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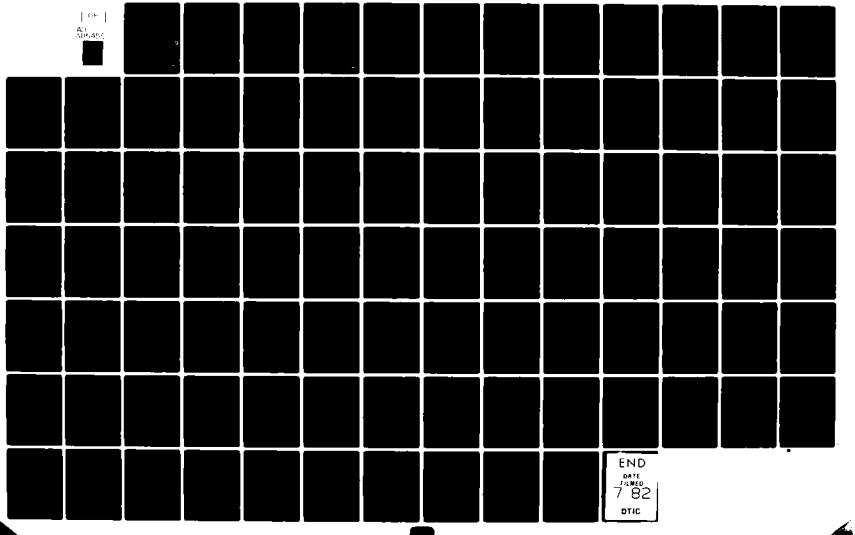

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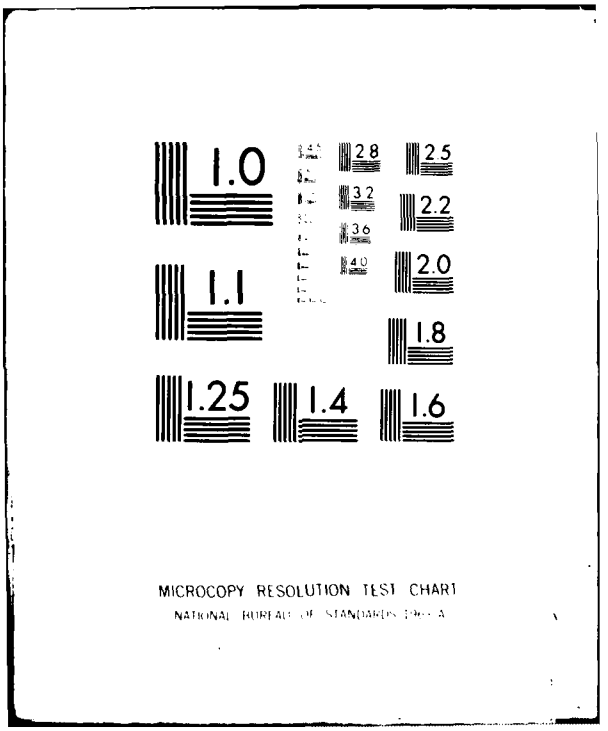
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A STUDY OF
EMBEDDED COMPUTER SYSTEMS SUPPORT

VOLUME III
REQUIREMENTS BASELINE:
AIRCREW TRAINING DEVICES

September 1980

APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED

CDRL 02A
Contract Number F33600-79-C-0540

Prepared for
Air Force Logistics Command AFLC/LOEC
Wright Patterson AFB, Ohio 45433

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Abstract: An Aircrew Training Device (ATD) is an electromechnical system used to train numbers of air crews or missile launch crews by simulation of the actual operating conditions, procedures, and environment. Volume considers the ATD category of Embedded Computer System Support. (See related volumes: LD 47169A, D, D, E, F, G, H, J, K & L).

Conclusions: See Volume I (LD 47169A).

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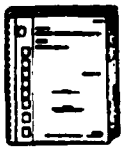

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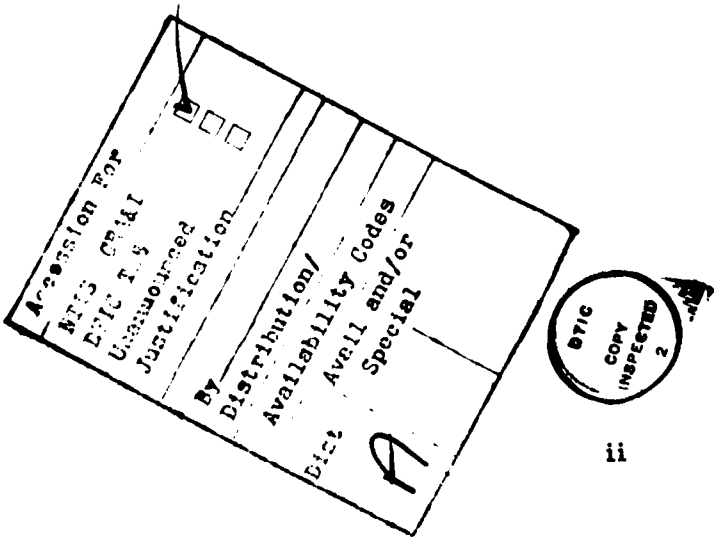
FOREWORD

This volume is one of nine individually bound volumes that constitute the Phase II Final Report "Study of Embedded Computer Systems Support" for Contract F33600-79-C-0540. The efforts and analyses reported in these volumes were sponsored by AFLC/LOEC and cover a reporting period from September 1979 through September 1980.

The nine volumes are

Volume	Title
I	Executive Overview (CDRL 05)
II	Selected ECS Support Issues: Recommendations/ Alternatives (CDRL 02A)
III	Requirements Baseline: Aircrew Training Devices (CDRL 02A)
IV	Requirements Baseline: Automatic Test Equipment (CDRL 02A)
V	Requirements Baseline: Communications-Electronics (CDRL 02A)
VI	Requirements Baseline: Electronic Warfare (CDRL 02A)
VII	Requirements Baseline: Operational Flight Programs (CDRL 02A)
VIII	ECS Technology Forecast (CDRL 03)
IX	National Software Works Investigation (CDRL 04)



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TABLES

ILLUSTRATIONS

ABBREVIATIONS AND ACRONYMS

ANG	Air National Guard
ATD	Aircrew Training Device
ATE	Automatic Test Equipment
C-E	Communications-Electronics
DTT	Development Technician Team
ECS	Embedded Computer System
EW	Electronic Warfare
FSG	Federal Supply Group
MAC	Military Air Command
MIP	Material Improvement Projects
MOA	Memorandum of Agreement
NSCCA	Nuclear Safety Cross-Check Analysis
NSS	Nuclear Safety Systems
OFP	Operational Flight Programs
PMRT	Program Management Responsibility Transfer
QM	Quick Modification
SAC	Strategic Air Command
SEL	System Engineering Laboratories
S^3C	Simulator Software Support Center
TAC	Tactical Air Command
TAWC	Tactical Air Warfare Center
TCTO	Time Compliance Technical Orders

1. AIRCREW TRAINING DEVICE CATEGORY DESCRIPTION

In this report the Aircrew Training Device (ATD) category of Embedded Computer System (ECS) is considered. The additional categories of ECS which are considered in separate reports are

1. Automatic Test Equipment (ATE)
2. Communications-Electronics (C-E)
3. Electronic Warfare (EW)
4. Operational Flight Programs (OFP)

1.1 INTRODUCTION

An Aircrew Training Device is an electromechanical system used to train members of air crews or missile launch crews by simulation of the actual operating conditions, procedures, and environment. The report considers only those ATD's which utilize a digital computer as part of the training device. Air Force ATD Systems containing ECS are included in the category, whether they train part or all of an aircrew for whole missions, mission segments, or other fragments of total operations. ATD's are used to

1. Maintain and improve combat readiness of experienced aircrews
2. Provide effective initial training for student pilots and aircrew members
3. Reduce training and operating costs
4. Conserve scarce resources such as energy, weapons, and ammunition

The majority of the ATD's in the category are ground based. The exceptions are mounted on an operational aircraft to provide certain training experiences not attainable either on the ground or in the air without these additional devices. Most of the attention has therefore been given to ground-based trainers.

In this study, the ATD category does not include trainers devoted to weapon system support functions, such as maintenance, ground support, ground electronic warfare, or missile systems checkout.

1.2 SCOPE

This ATD study has been performed to determine ECS support problems associated with maintenance of ATD unique software. Problems such as the logistics lifetime of off-the-shelf ECS hardware and peripherals, maintaining (or not maintaining) ECS equipment and ECS vendor supplied software to the current ECS vendors configuration, ECS maintenance philosophy (blue suit, government organic, or contract), etc. are addressed only when related to maintenance of the ATD custom software.

1.3 DEFINITIONS

Several definitions are offered here so that a common basis of understanding is established for discussion of ATD support.

1.3.1 Embedded Computer System

A computer system which is integral to an electromechanical system such as a combat weapons system, tactical system, aircraft, ship, missile, spacecraft, certain command and control systems, electronic warefare systems, crew trainers for such systems, automatic test equipment, etc.

1.3.2 Aircrew Training Devices Software

Software which executes in host/embedded trainer system computer(s) and performs functions necessary to simulate the environment and operation and mission training functions in support of the primary weapon system.

1.3.3 Computer Resources

The totality of computer equipment, computer programs, computer facilities, associated documentation, contractual services, personnel, and computer supplies.

1.3.4 Primary Weapon System

The operational system for which the ATD trains crew members. It may be a true weapon system, electronic warfare system, or a subsystem that requires one or more aircrew members to operate it. The term is used in this report to differentiate between the ATD and the wea-

pon system the ATD supports.

1.4 ATD SYSTEM IDENTIFICATION

Most aircraft and missiles in the Air Force inventory are supported by ATD's. Each trainer is operated by a user command, e.g., TAC for the F-4. Multiple ATD's may be used to support specific weapon systems. Trainers are assigned an ATD unique type designated, e.g., A/F37U-T9 for the F-4E. These type designations are included in Appendix A. For clarity, in this report ATD's are designated by the name of the primary system (e.g., F-4E) and the trainer purpose (e.g., Weapon System Trainer) rather than by type designation.

Table 1-1 summarizes the types of trainers and the number of models which contain an ECS. The information in this table summarizes the data given in Appendix A, ATD Computer Systems Inventory and Description. Other trainers are planned but not included in Table 1-1 (e.g., the B-52 Weapon Systems Trainer which is in source selection and not as yet fully defined). Section 4, Representative ATD Systems, describes a small sample of these ATD's more fully.

The embedded computers included in this category cover a diverse range of manufacturers, sizes, and equipment mixes. In the 64 unique models of ATD's in Appendix A, 97 ECS items are listed. Because Appendix A does not include a count of the number of copies of one model of an ECS in a particular ATD, the total number of individual ECS in the 64 ATD models is greater than 97. For example, there are three Harris 6024/4 computers in the F-15 Mission Simulator, which are counted as one ATD ECS in reaching the total of 97. A total of 42 models from 20 manufacturers are included, most of which can be considered standardized general purpose computers. The total number of computer programs being supported has not been determined, although it certainly exceeds 97, since there are multiple ECS of the same model in many ATD's and some ECS computers have more than one program. The ATD ECS range in memory size from 6,000 bytes to 4 megabytes. Because all trainers of an ATD model need to be changed when an update occurs, the quantity of a particular ATD model (number of copies) in Appendix A indicates the severity of the distribution problem.

Table 1-1. ATD's with ECS

Primary Weapon System	ATD Name	Number	User Command †
Fighter Aircraft (F-4 series, F-111, F-15, A-10, F-16, F-5, A-7)	• Mission Simulator	(6)	TAC (ANG)
	• Weapon System Trainer	(5)	TAC
	• Operational Flight Trainer	(2)	TAC
	• Flight Simulator	(2)	TAC
Transport Aircraft (C-130, C-5A, C-141, C-135)	• Flight Simulators	(5)	MAC
	• Mission Simulator	(1)	MAC
	• Cockpit Procedures Trainer	(2)	MAC
Bomber Aircraft (B-52, FB-111)	• Mission Simulator	(1)	SAC
	• Flight Simulator	(6)	SAC
Trainer Aircraft (T-37, T-38)	• Undergraduate Pilot Trainers	(2)	ATC
Helicopters	• Helicopter Trainers	(2)	MAC
ICBM (Minuteman)	• Procedures Trainer	(11)	SAC
	• Missile Guidance Training Set	(5)	SAC
Other (E-3A, EW Units, ACMI, etc.)	• Special Purpose	(14)	ATC, TAC, SAC, MAC
Total Unique ATD		(64)	

† TAC: Tactical Air Command; ANG: Air National Guard; MAC: Military Airlift Command; SAC: Strategic Air Command; ATC: Air Training Command.

1.5 TYPICAL ATD SYSTEM FUNCTIONS

The functions performed by the various trainers may include some or all of those listed in Table 1-2. Some, such as dynamic flight simulation and instructor displays, are found to some extent in all trainers. Other functions are dependent on the trainer's purpose. Some functions are usually mutually inclusive, such as aircraft motion simulation and g-loading. Still other functions are unique to the ATD Category, such as crew performance scoring. Many of the items in Table 1-2 are comparable to functions required in the support facilities for operational flight programs, and for electronic warfare which usually require an aircraft flight simulation. However, current hardware architecture and software implementation in existing trainers is usually different than in OFP or EW support systems.

Trainers for aircraft crews prepare and train the personnel in most aspects of flight operations including:

- Pre-flight ground procedures - aircraft pre-flight and checklists, taxiing, communications, calibration, and alignment.
- Takeoff/landing - departure and approach procedures, handling, use of cockpit aids, use of approach, and landing lighting display.
- Flight operations - air traffic control procedures, use of communications equipment, navigation equipment, radar systems, elctronic warfare devices, and weapon systems. This may include use of windshield displays of training scenarios, landmarks, and other cues.
- Combat tasks - air-to-air combat, air-to-ground weapons delivery. This may include use of fire control systems, head up displays, etc.

Generally, weapon system trainers provide the most complete training for a particular weapon, possibly involving all members of the crew simultaneously. Mission simulators generally are pilot oriented, involving all phases of flight. Air combat simulators require the ability to model cues, including visual, of a second aircraft and/or missile. Similarly, helicopter trainers are for specialized capabilities, as are the missile crew and electronic warfare trainers. Undergraduate training is generic for specific functions such as piloting or navigating. In addition,

Table 1-2. Typical ATD System Functions

Function	F-4E	F-15	B-52	C-141
Dynamic Flight Simulation	X	X	X	X
Aircraft Motion Simulation	†	†	X	
G-Loading Simulation	X	X		
Simulated Flight Recording	X	X	X	X
Malfunction Simulation	X	X	X	X
Weapon Scoring	X	X	X	
Electromagnetic Environment	X		X	
Countermeasures Stimulation			X	
Terrain Tracking‡				
Radar Land Mass Simulation	X			
Visual Display	X	X	X	X
Target Generation	X	X	X	
Instructor Displays	X	X	X	X
Communication Simulation	X	X	X	X
Signal Processing‡				
Crew Performance Scoring	X	X	X	X

† Motion system has been/will be disabled and replaced by G-loading simulation.

‡ While not functions of the four representative systems, these functions are in other ATD.

there are special purpose trainers for missile launch crews. For this study, electronic warfare trainers are limited to those involving the training of aircraft crew members, although there are numerous other aspects of EW training involving simulators. The aircraft-mounted ATD's are used to train the crews in interactions between their aircraft and its environment without complete actual operations. Particular areas of usage are weapon firing and scoring. At present, these devices are numerically a small part of the category, but are expected to increase in importance over the next decade.

The main elements of the typical weapon system simulator are:

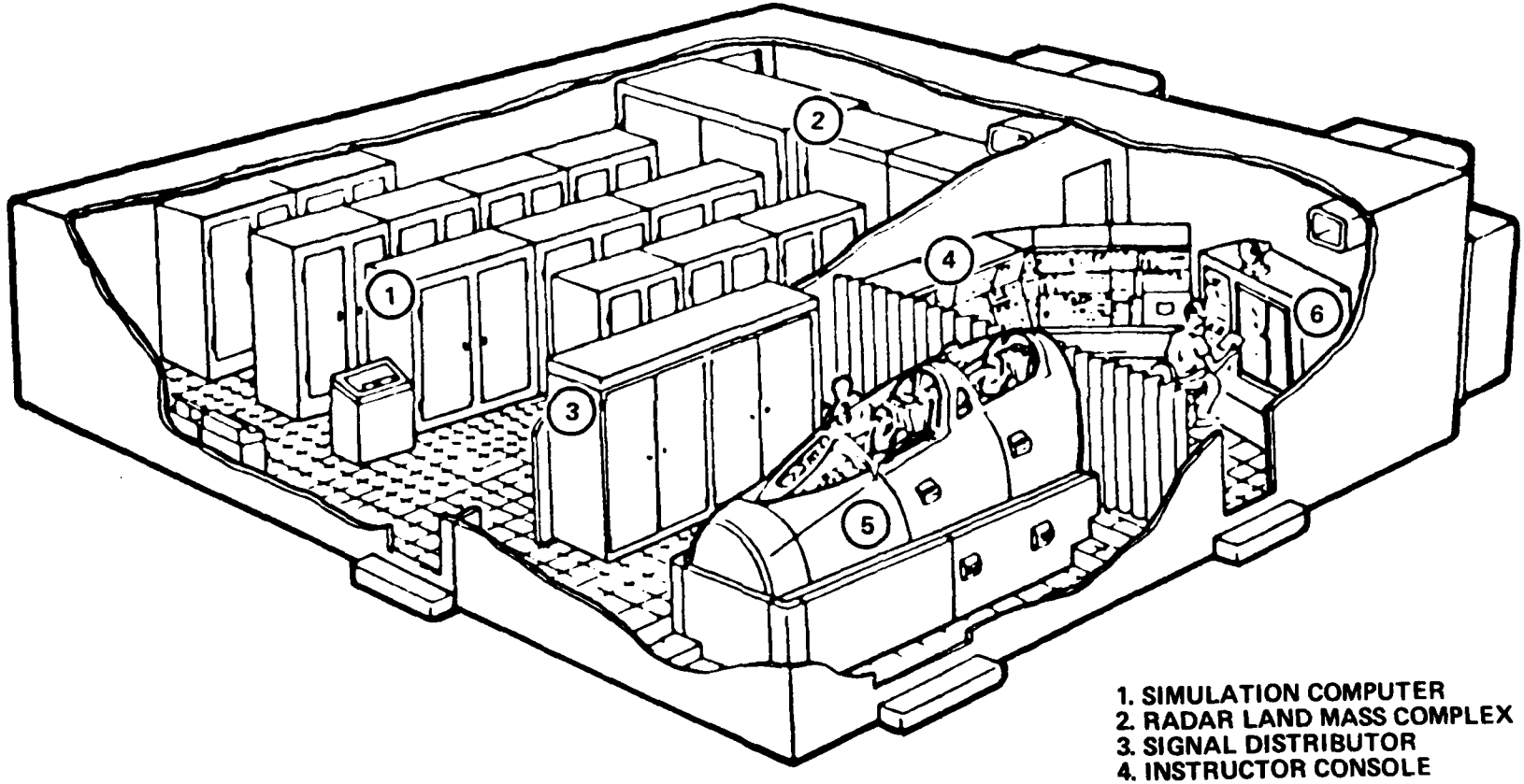
- Cockpit mockup
- Motion base or g-effect system
- Visual system
- Embedded computer system(s) complex
- Instructor stations
- Processor interfaces

Figure 1-1 shows conceptually how the main elements are arranged. Usually, the cockpit mockup is separated from the instructor console and support equipment. The number and variety of ECS depend on many factors, including the number and type of special purpose processors required.

1.6 ATD SYSTEM MISSION

Training devices have been built to train crew members in a fixed-location controlled environment. The mission is to provide training in operational tasks without using operational equipment. The advantages include:

- Safety - errors of procedure or judgment do not cause crashes or other failures that endanger life or damage equipment.
- Increased proficiency - training can be tailored to emphasize a particular part of a mission which has been shown to be difficult, e.g., air-to-air combat, approach under instrument landing conditions, air-to-air refueling, etc.



1. SIMULATION COMPUTER
2. RADAR LAND MASS COMPLEX
3. SIGNAL DISTRIBUTOR
4. INSTRUCTOR CONSOLE
5. PILOT COCKPIT
6. AUTOMATED ADAPTIVE FLIGHT TRAINING SYSTEM

Figure 1-1. F-4E Weapon System Simulator

- Repetition - the same exercise sequence can be repeated indefinitely, with external stimuli and initial conditions also repeatable.

- Flying hours avoidance - training proficiency can be maintained at lower cost due to reduction of wear and tear on the weapon system and/or reduction of fuel usage.

In some cases, elements of training can be performed via ATD's that cannot actually be performed with the weapon system, such as air-to-air combat with weapons fired, engine failure on takeoff, approach to landing with weather below minimums, etc.

1.7 OPERATIONAL STATUS

The training devices of this category are in various stages of the life cycle. For each ATD, the status is given in Appendix A. Following PMRT, the ATD system manager (Trainer Division, MMF, at Ogden ALC) is responsible for executive management of these systems.

Most of the ATD's are ground based, fixed site installation. Almost all of the ECS hardware items are general purpose "off-the-shelf" computers and peripherals. There is no requirement for ruggedization, compactness or other features such as those needed for a flight environment. With these computers the operating system, library, and support software are usually supplied by the computer manufacturer. The ECS are physically embedded in the ATD, remotely located from other computer facilities and unavailable for alternate applications.

The various types of training devices, as defined by AFR 50-11, "Management and Utilization of Training Devices", are listed below:

- Part Task Trainer (PTT) - operator trainers which let selected aspects of a task (fuel system operation, hydraulic system operation, radar operation, etc.) be practiced and a high degree of skill developed independently of other elements of the task.

- Cockpit Familiarization Trainer (CFT) - device that presents a facsimile of the flight stations of a specific aircraft. It is used to make it easier for the trainee to learn where the various controls, instruments, switches, and lights in the cockpit are located. It also helps the trainee to learn tasks that must be repeated, such as the use of checklists, and normal and emergency operating procedures. The controls, switches, and instruments do not have to respond to trainee inputs.

- Cockpit Procedures Trainer (CPT) - device used to provide aircrews training in normal, alternate, emergency, and instrument flight procedures. Aircraft instruments and other indicators respond to trainee control inputs; exact dynamic simulation of all functions is not required.

- Mission Trainer (MT) - device that provides the trainee (or trainees) with a simulated warfare environment that is mission-oriented to the type weapon system involved. The trainer provides specific weapon system operator modes or a mission mode that requires tactical decision making. The trainee is faced with in-flight problems that energize aircraft sensors and respond with acquisition, identification, tracking evasion, and retaliatory weapons management. This does not apply to pilot devices.

- Operational Flight Trainer (OFT) - device that dynamically simulates the actual flight characteristics of a particular aircraft. Such devices help train flight crews in cockpit, instrument flight, emergency communications, and navigation procedures, as well as limited mission execution.

- Weapon System Trainer (WST) - device which provides a synthetic flight and tactics environment. It helps aircrews learn, develop, and improve the techniques that relate to their crew position in a specific aircraft. Aircrews work individually or as a team in completing simulated missions.

- Missile Procedures Trainer (MPT) - device that reproduces the environment, command, and control functions of a launch control center. It provides individual or crew training in all aspects of the operational missions.

- Ground-Based Electronic Signal Simulators - signal generating devices that emit electromagnetic energy patterns that represent hostile-threat radar systems.

- Mobile Training Set (MTS) - portable equipment such as training aids, and operational equipment used for supporting maintenance training.

- Resident Training Equipment (RTE) - trainers and training aids used in resident training programs to support training on specific systems or equipment.

Embedded ATD computers are supported by Warner Robins ALC under Federal Supply Group (FSG)-70 regulations. The role of the FSG-70 manager is to provide logistic and contractor maintenance support for the embedded computers and peripherals. Support responsibility for the trainer peculiar hardware and software (other than general purpose ECS hardware and computer vendor supplied software) is in general the responsibility of MMF at OO-ALC.

2. ATD CATEGORY ECS SUPPORT REQUIREMENTS

Embedded computer resource support in aircrew training devices consists of basically the same component elements as in the OFP, EW, C-E, and ATE categories, and the same generic support requirements exist as in the other categories. These generic support requirements, which are common to the other ECS categories, are:

- ECS change
- Change analysis and specification
- Engineering development and unit test
- System integration and test
- Change documentation
- Certification and distribution

Additionally, two unique ECS support requirements currently exist. The major unique aspect to supporting the ECS in an ATD is the need for a concurrency relationship with the primary weapon system. Concurrency pertains to having the configuration of the trainer always correspond to the configuration of the primary weapon system, as far as training functions are concerned. A second unique support requirement is caused by use of commercially available off-the-shelf ECS hardware, peripherals, and system software, which causes differences in maintenance and provisioning problems (due to FSG-70). Also, the commercial ECS are generally considered to have a logistically supportable life of under 10 years. Table 2-1 presents a brief summary of each support requirement.

2.1 ECS CHANGE

In general, ATD category ECS change can be traced to one of four causes:

1. Primary weapon system change
2. Deficiency in modeling primary weapon system
3. Enhancement of ATD capability
4. Logistics supportability

Table 2-1. ATD System Support Requirements

ATD Change Requirement	Remarks
ECS Change	
• Receive and Process Requests	• Change requests can originate from a number of sources and can range in importance from emergency/urgent to desired or nice to have. Procedures are required to record and track all change requests.
• Preliminary Analysis and Problem/ Deficiency Definition	• This activity can be accomplished in varying degrees by the requestor and the supporter depending upon the nature of the problem and the knowledge and tools available.
• Preliminary Resource Allocation and Scheduling	• Involves priorities and coordination with user and sources of support depending upon nature and number of changes.
Change Analysis and Specification	
• Feasibility	• Can the change be accomplished? If not - why? If yes, what is the approach to the solution? What are the likely software, hardware, and system impacts?
• Requirements Decomposition/ Definition	• The selected design approach is examined and resource requirements are further detailed for selected approach.
• Preliminary Design	• Preliminary design and testing approach is established. Technical conferences and Preliminary Design Reviews (PDR's) are held.
• Detailed Design	• Design approach is finalized; specification, test procedures, and development plans are prepared/updated. Critical Design Reviews (CDR's) are held.
• Generate Change Proposal	• Document results of technical evaluation and analysis, generate and distribute the Computer Program Change Proposal (CPCP).
Engineering Development and Unit Test	
• Develop the Change	• Implement the design, coding of computer program changes, coordinate if also a hardware change.
• Perform Engineering Tests	• Module/code level testing of the newly compiled program.
System Integration and Test	
• Test ATD System Performance	• Ensure that as-coded change satisfies requirements and has no adverse affects on the operation of the unchanged parts of the ATD software programs.
• Test Weapon System Performance	• Ensure that change or changes satisfy system requirements without adverse affect; includes flight test depending upon nature of change.
• Produce Test Results	• Analysis of simulation/flight test and documentation of results.
Change Documentation	
• Document ATD Change	• Update specific change in all working documents.
• Update ATD Baseline	• Update ATD specifications and support system specification as necessary.
• Configuration Control	• Establish new baselines for formal control.
Certification and Distribution	
• Certify Documentation	• Administrative sell-off/buy-off.
• Distribute Revised ATD Data	• Prepare and coordinate technical publications.
• Provide Installation Procedures/ Instructions	• Participate in installation of change.
Unique Requirements	
• Concurrency	• ATD modifications necessitated by changes to the primary weapon system should be fielded at least 90 days prior to the primary weapon system modification.
• Commercial ECS	• The supportable life of commercial ECS is generally considered to be less than 10 years, which is much shorter than the typical weapon system's life.
• Inter-Agency Coordination	• Systems with DEPS manned largely or entirely by the using command (TAC, MAC, SAC, etc.), require more complicated configuration management procedures.

Each ATD is designed to model, from the viewpoint of an aircrew member, all or part of a primary weapon system. Changes in the primary system which affect its aircrew interface may need to be concurrently changed in the trainer to prevent incorrect or "negative" training.

Deficiency corrections in ATD's are similar to corrections in the other categories. The sources are generally the users - instructors and crew members - and the ECS support personnel. Users identify symptoms, a common one being that the trainer does not "feel" like the aircraft, or similar vague but valid comments. A goal of trainer support is to provide the maximum modeling fidelity in areas where crew response training is effected. The change requests are entered into the support process in response to these user observations.

Enhancements are constantly introduced to improve the usefulness of the ATD in performing its mission. A need for new displays or added capabilities can result from problems encountered in use. Incidents or malfunctions that occur while operating the primary weapon system often lead to new trainer requirements.

Changes to improve logistics supportability are needed when supplies of hardware components become unavailable for ATD maintenance, e.g., when the original manufacturer stops producing the part and alternate qualified suppliers are not available.

When candidate changes to the ECS are identified, certain activities are required in any software support system. These change request processing activities are as follows.

2.1.1 Receive and Process Requests

Requests can come from three separate sources, the primary weapon system SPO or SM, the user community, or occasionally the trainer hardware IM. Generally, the SPO or SM will request concurrency changes, while the users will request deficiency or enhancement changes. The hardware IM would request changes to improve logistics supportability. The ATD support requirement includes the need to react to these different sources.

2.1.2 Preliminary Analysis and Problem/Deficiency Definition

An analysis is required to determine if each change to the primary weapon system does or does not require a change to the ATD, and to define the change. All reported deficiencies and enhancement requests need to be evaluated for validity, feasibility, and cost effectiveness. The preliminary analysis and disposition of the request often entails the conversion of vague user comments to firm engineering descriptions and cost estimates. Evaluation is required to determine if the deficiency is real or imagined, or if its repair is within the realm of the trainer capability.

2.1.3 Preliminary Resource Allocation and Scheduling

Some changes are higher priority than others, such as those affecting safety procedures. For all accepted changes, the support agency must allocate resources, possibly both organic and contractor, and schedule the activity.

2.2 CHANGE ANALYSIS AND SPECIFICATION

Each change must be defined in terms of the individual ATD, although it may have been identified in terms of the primary weapon system. OFP changes need to be redefined in terms of the ATD's simulation of OFP functions. It is conceivable that a minor OFP change would not require a corresponding ATD software change. Conversely, it could lead to a large ATD change.

2.2.1 Establish Change Feasibility

Feasibility is based on possible design approaches that are compatible with the basic system, e.g., a change which requires large memory may not be feasible, but the purchase of additional hardware memory may increase feasibility.

2.2.2 Requirements Decomposition/Definition

Based upon the feasibility analysis, a design approach is chosen, and requirements are defined and decomposed among the subsystems.

2.2.3 Preliminary Design

The preliminary design is further defined, a means of development established, a concept of testing identified, and operational problems and procedures identified.

2.2.4 Detailed Design

Design procedures are needed to support engineering management of the change. Design may be created organically or by contractor.

2.2.5 Generate Change Proposal

The change proposal is the technical description of the work to be performed and the basis for management approvals. It is also used to define contractor involvement.

2.3 ENGINEERING DEVELOPMENT AND UNIT TEST

The ECS of ATD's are mainly general purpose machines located in a laboratorylike environment. This makes it possible to develop test requirements and perform the unit tests on the object ECS.

2.3.1 Develop the Change

The engineering prototype needs to be developed to be compatible with all trainers in the affected series. The prototype is the basis for evaluation and test of the change. If contractor developed, this activity includes review by the technical personnel assigned by the contracting agency.

2.3.2 Perform Engineering Tests

All work units of hardware and/or software are separately tested as they are developed to see that the desired technical functions of the change are working, the engineering integrity of the programs are valid, and no unusual or problem areas persist with the change.

2.4 SYSTEMS INTEGRATION AND TEST

2.4.1 Test ECS System Performance

Changes to ECS hardware or software must be tested as a subsystem prior to integration. In ATD's, the ECS is usually a standardized general purpose computer, located in an adequate facility where all peripheral

devices needed to exercise the system are available. If is therefore possible to test the ECS system directly; there is no need to simulate or emulate the computer and its software. Testing needs to be performed to a sufficient level of thoroughness to provide confidence the changes meet the design purpose.

2.4.2 Test Aircrew Training Device Performance

Integrated ATD performance tests must show that the change corrects the problem of making the ATD model concurrent with the aircraft, removes the deficiency, or enhances the capability. Integrated tests should also verify that other functions are not inadvertently altered. However, the nature of the trainer's mission requires a less stringent level of test (and verification) than some primary weapon systems. For instance, systems delivering nuclear weapons must undergo complex Nuclear Safety Cross-Check Analysis (NSCCA) prior to fielding changes. It is always desirable to thoroughly test and verify any ECS change, but the high costs of NSCCA testing are not justified for ATD's. Most ATD changes may be word verified through use, utilizing the feedback of users, as discussed above. Verification should include acceptance testing by the user and originator of the change request.

2.4.3 Produce Test Reports

All final testing should be well documented. The long life of ATD's - as long as the weapon system is operational - and highly changeable configurations make it necessary to document test methods and results. These documents are an aid to acceptance testing and fielding installation of changes.

2.5 CHANGE DOCUMENTATION

This subject is as important to this category as to any other. More than one organization is involved between users and supporters, and the long lifetime of the systems (F-4 trainers were first deployed in 1965 and will be in the inventory into the 1990's) implies significant turnover of personnel during that lifetime.

2.5.1 Document ECS Change

All working documents, including specifications, must be updated to provide a valid working baseline of reference material for use in the on-going support activity. Documents must also support the installation and the user during operations.

2.5.2 Update ECS Baseline

When changes are made to the operational configuration, the baseline must be updated, including software media, hardware drawings, and all documentation.

2.5.3 Configuration Control

Through the final stages of development and testing the various trial and final versions must be rigidly controlled so that incremental progress is benchmarked and catastrophic failure will not set the development process back beyond the benchmarked capability.

2.6 CERTIFICATION AND DISTRIBUTION

A central point of authority must certify that a change is completed, correct, and should be fielded. Each model of an ATD may be deployed to training locations anywhere in the world where the primary weapon system is stationed. It is important that all updates be installed at all such sites. The support agency is required to certify that all updates are made and are operating as part of the support function. In some cases, the issue of concurrency may enter into distribution and installation needs.

2.6.1 Certify Documentation

The revised baselined documentation must be administratively recognized by a central authority as the new baseline.

2.6.2 Distribute Revised ECS Data

The revised/updated ECS data and related system changes to hardware, support system, training, technical publications, and support documentation are distributed to cognizant agencies.

2.6.3 Provide Installation Procedures/Instructions

The user may install the changes provided adequate procedures and instructions are available to describe the installlation. Certain updates may not be within the user capability and may require the support of specialized personnel.

2.7 ATD CATEGORY UNIQUE SUPPORT REQUIREMENTS

2.7.1 Concurrency

The configurations of the primary weapon system and the ATD must be closely synchronized to provide valid training on the ATD. The alternative is to generate misleading learned responses, referred to as "negative training". For example, if a new avionics capability is added to an aircraft OFP, but not incorporated in the ATD model of the OFP, the crew members being trained will practice and learn the outdated responses in the ATD, then have to relearn the affected operations and tasks while flying. To avoid this situation, there is a support requirement for the timely updating of the ATD to reflect changes to the configuration of the primary weapon system so that aircrew members can become familiar with the modifications before trying to fly or operate the actual system. AFR 57-4 states, "Trainer modifications should lead the weapon system modification by at least 90 days...." without delaying the weapon system modification release. In a support environment, this involves extensive coordination by the supporters of the weapon system and the ATD. Although AFR 57-4 advocates a 90-day lead time, this is seldom achieved because of funding delays and administrative restrictions. In addition, the ATD is slaved to the weapon system and the ATD support personnel are dependent on their primary weapon system counterparts for all technical information.

2.7.2 Commercially Available ECS

The use of commercially available, off-the-shelf computers as ECS in an ATD causes some changes in hardware and software support requirements as compared to other categories of ECS. The commercially available ECS are, in general, widely used by industry. The USAF is a buyer of only a small percentage of the total number of units manufactured. The

largest reservoir of spare parts and maintenance expertise therefore lies in industry. However, as a computer system ages it tends to be phased out by industry (generally with a 10-year or less useful life) and maintenance/spare parts support is no longer economically available from the commercial world. Hardware and software support philosophy for ATD ECS should consider these special problems of commercially available computer equipment.

2.7.3 Inter-Agency Coordination

With modifications developed by the DEPS team or by contractor under AFLC control, more complex inter-agency coordination and configuration control is required to ensure a correct definition of contractual baselines, to ensure that the DEPS has a knowledge of the ALC's contractual activities and their affect on DEPS workload, and to ensure that the ALC has, at all times, correct baseline documentation.

3. ATD CATEGORY ECS SUPPORT CONCEPTS

Aircrew training device ECS software is supported at selected training sites under the "DEPS† Concept". The central points of this concept are that each trainers model has Development Engineering Prototype Site (DEPS) designated for its support, the support activity is performed at one of the weapon system's operational training sites, and support personnel represent the user (training) commands, possibly assisted by a resident OO-ALC engineer. Certain user commands (MAC, TAC, ANG) also support minor hardware changes at DEPS.

The DEPS is comparable to the Simulator Software Support Center (S^3C) described in the Pacer Flash report. Since that time, the use of embedded computer systems in ATD's has expanded in size and range of functions, but the basic elements have not changed. Pacer Flash is recognized as the definitive source of the DEPS concept; however, the concept had evolved and was in use prior to that time. A comceptual DEPS is shown in Figure 3-1.

3.1 DEPS DESCRIPTION

A DEPS is a site where an ATD is installed and used for both training and support activities. The unit serves a dual purpose of training and support, thereby avoiding the need to purchase an additional unit for support. The particular location is chosen to best meet the needs of the commands, user, and logistics.

The DEPS consists of the following major elements:

- Aircrew training device
- Engineering support tools
  - Hardware and electronics shop
  - Computer system peripherals
  - Software development/modification tools
- Documentation
- Facilities
- Personnel from the using command
- Engineering personnel from OO-ALC (at selected DEPS)

† ATC calls the DEPS, Software Support Centers.

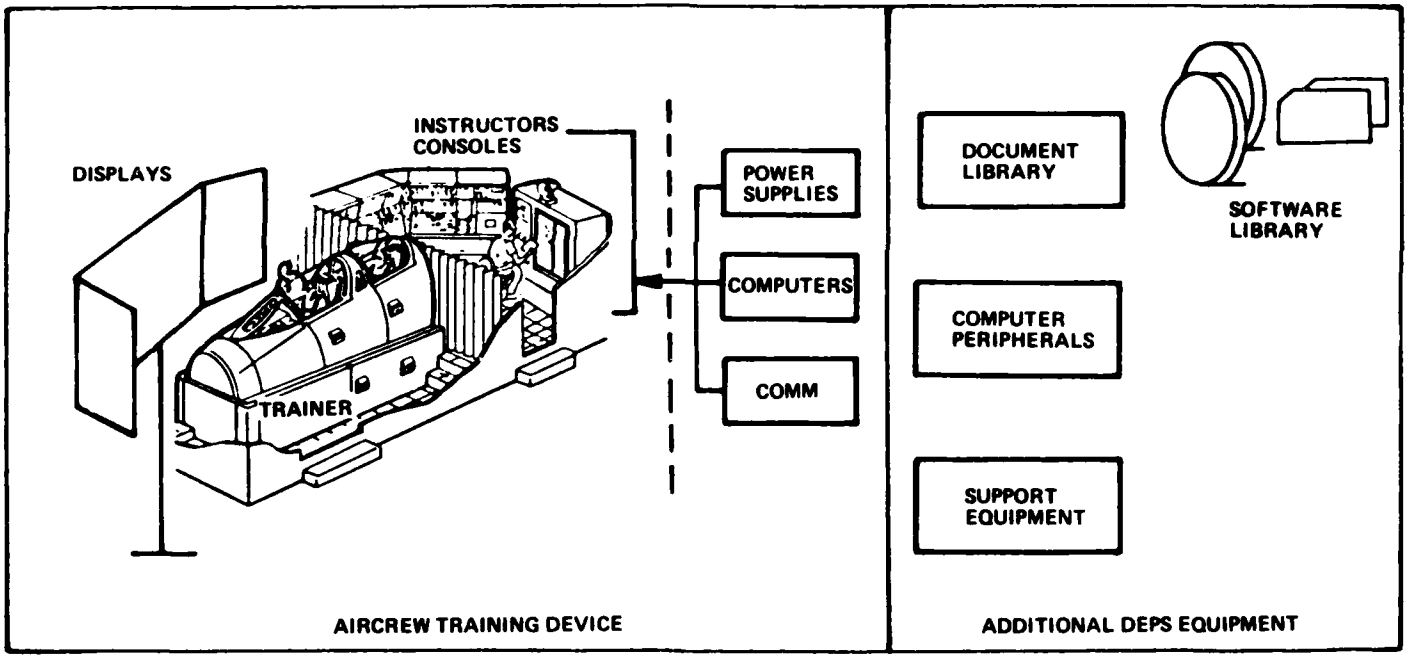


Figure 3-1. Conceptual View of DEPS

3.1.1 ATD's in DEPS

The ATD at the DEPS is located with one of the operational units deployed to training sites. The DEPS may support more than one functionally related trainer model. As an example, the F-4E DEPS at Luke AFB also supports the RF-4C and F-4C, where the three aircraft models are in the same family. Another example is the B-52 flight simulators and B-52 EW trainer at Castle AFB, which are physically separate devices training different crew members, but for the same primary weapon system.

3.1.2 Support Tools

Certain engineering support tools are required at the DEPS. In general, the engineering support tools are selected to meet the particular needs of each DEPS. These consist of light shop tools (e.g., drill presses, saws, and hand tools), electronics repair tools, and electronic instruments. Support of the ECS requires input/output peripheral devices whose characteristics depend of the ECS being supported. Disk equipment, paper or magnetic tape equipment, card punch, and readers are usually needed. An off-line computer may also be necessary. For ECS software developed in a higher order language, a compiler is required. Other software tools, such as assemblers, cross reference generators, and auditors may also be made necessary. Firmware support requires PROM burners.

3.1.3 DEPS Documentation

Documentation required to perform the support functions needs to be available at the DEPS. This includes technical orders, specifications, and systems descriptions on the primary weapon system. Also, ECS manuals, program description documents, user guides, listings, and flow charts are needed for the ATD. ATD acceptance test cases and results also form part of the documentation data base.

The same level of documentation is required for DEPS support equipment as is required for the ATD. This is especially true for computer systems and support software.

3.1.4 DEPS Facilities

The DEPS facility requirements are similar to those at non-DEPS training sites. However, additional space is required for DEPS support personnel to work in, and to house additional support equipment, such as peripheral devices or an off-line computer. A storage capacity for DEPS documentation is also required.

3.1.5 Support Personnel

At the DEPS, organic support capability is provided by a resident team from the user command and by the ALC resident engineer, if assigned. The user command support team is usually referred to as either a DEPS team or Development Technician Team (DTT) and is composed of senior and qualified trainer technicians. The ALC engineering representative (if any) is responsible to the Ogden ALC System Manager (Trainer Division MMF) and works alongside the team. He provides professional engineering level capability and training to augment the technicians of the DTT. In concept, he provides a link between the commands at the working level. While his role is not clearly defined by existing MOA's, in most cases the resident ALC engineer performs as a productive member of the DEPS team.

3.2 DEPS LOCATIONS

DEPS are assigned resident ALC engineering representatives if they have a sufficiently high workload and if such support is requested by the MAJCOM. Currently, there are eight DEPS having a present or planned ALC resident engineer, as listed in Table 3-1. Each DEPS is identified by the name of the primary weapon system, e.g., the aircraft. Three of the four vacant ALC representative slots are for pre-PMRT trainers. The fourth vacant slot (F-4E) will be filled when a qualified engineer becomes available.

In addition to the sites shown in Table 3-1, there are 16 others, whose trainers are supported without a resident ALC engineer, as listed in Table 3-2. These locations meet the DEPS concept in all other respects, including the presence of a user command support team.

Table 3-1. DEPS Locations with ALC Representative

Weapon System	Location	ALC Rep	User	PMRT
FB-111	Plattsburg AFB, NY	Manned	SAC	Transitioned
F-4E	Luke AFB, AZ	Vacant	TAC	Transitioned
A-10	Davis Montham AFB, AZ	Vacant	TAC	1982
F-15	Luke AFB, AZ	Vacant	TAC	1982
F-4G	George AFB, CA	Vacant	TAC	1980
T-37, 38	Randolph AFB, TX	Manned	ATC	Transitioned
ACMI	Nellis AFB, NV	Manned	TAC	Transitioned
B-52, KC 135, EW	Castle AFB, CA	Manned	SAC	Transitioned

Table 3-2. DEPS Locations without ALC Representative

Weapon System	Location	User	Comments
A-7D	Myrtle Beach	TAC	Low support level required
	Buckley	ANG	
F-4C	Luke	TAC	To be added to F-4E DEPS
RF-4C	Luke	TAC	
F-4D	Nellis	TAC	
F-111	Mountain Home	TAC	
F-16	TBD	TAC	
C-130	Little Rock	MAC	
C-5A	Altus	MAC	
C-135B	Altus	MAC	
C-141A	Altus	MAC	
Other Trainers			
SAAC		TAC	Air-to-air combat
UNTS	Mather	ATC	Navigation trainer
MATTS	Nellis		Aircraft mounted device
ATCS			Air traffic control simulator
MM Missile	Hill	SAC	Group of 16 training devices

3.3 CHANGE CONCEPT AND PROCESS

Within the DEPS concept, changes to ECS hardware and software can be developed either organically by the DEPS support team or by contractors through the Ogden ALC. The choice depends on the source of the change, its complexity, other work load, and funding considerations.

Change requests come from the responsible weapon system manager, the ATD system manager, the hardware item manager, the user community, or are generated by the DEPS team. The system manager at Ogden ALC is the usual recipient for concurrency change requests and for major defficiency requests from the user command.

When there are changes to the primary weapon system, the request for ATD modifications for concurrency usually comes from the weapon system SPO or item manager, depending on responsibility. These requests are sent directly to the ATD system manager. Other deficiency requests from all sources may be submitted to OO-ALC. Both software and hardware deficiencies are submitted as Material Deficiency Reports (MDR's). Material Improvement Projects (MIP's) are generated as a result of an MDR submission.

The need for deficiency removal or enhancement is usually identified by the trainer users or the user command, who provide data to the DEPS team. The user command may also notify the ATD system manager.

3.3.1 Organic Modification Process

The DEPS team generates organic modifications under the Quick Modification (QM) concept. The Quick Modification is allowed under AFR 57-4 for flight and missile crew trainers when the AFLC and involved MAJCOM have negotiated a memorandum of agreement. There is an existing memorandum dated February 1979 which provides the guidance and vehicle for the using command operating locations to identify deficiencies/enhancements and to engineer and test a proposed change. The quick modification program recognizes that there are capabilities in the field to design and prototype changes to the ATD's system. Table 3-3 lists the signatory offices.

Table 3-3.

Signators to Quick Modification Concept
Memorandum of Agreement

Command	Office
Aerospace Defense Command	LGM
AF Acquisition Logistics Division	SD16
Aeronautical Systems Division	SD24L
Air Training Command	LGM
Military Airlift Command	LGM
Pacific Air Forces	LGM
Strategic Air Command	LGM
Tactical Air Command	LGM
Alaskan Air Command	LGM
U.S. Air Forces Europe	LGM
Air Force Reserve	LGM
Air National Guard	LGM
Ogden Air Logistics Center	MM
HQ AF Logistics Command	LO

The organic modification concept depicted in Figure 3-2 is a flow of the major steps in the change process. These steps apply to both hardware and software. The DEPS team performs the technical evaluation and feasibility study, although the originator may have built and tested a version of the change. User command headquarters reviews the team's results, and if approving, prioritizes the prototype development. When the quick modification is completed, a QM data package is sent to the user command(s) CCB for their approvals, then sent to Ogden ALC.

At Ogden, the QM documentation is reviewed, the change is compared to the baseline data and evaluated, and a recommendation for CCB approval or disapproval is prepared. If the ALC CCB approves, Time Compliance Technical Orders (TCTO) are prepared, the baseline documentation is updated, modification kits are prepared (if required) and the change is distributed to all affected trainer locations. Actual distribution of software media is controlled by OO-ALC and duplicated by the DEPS for distribution

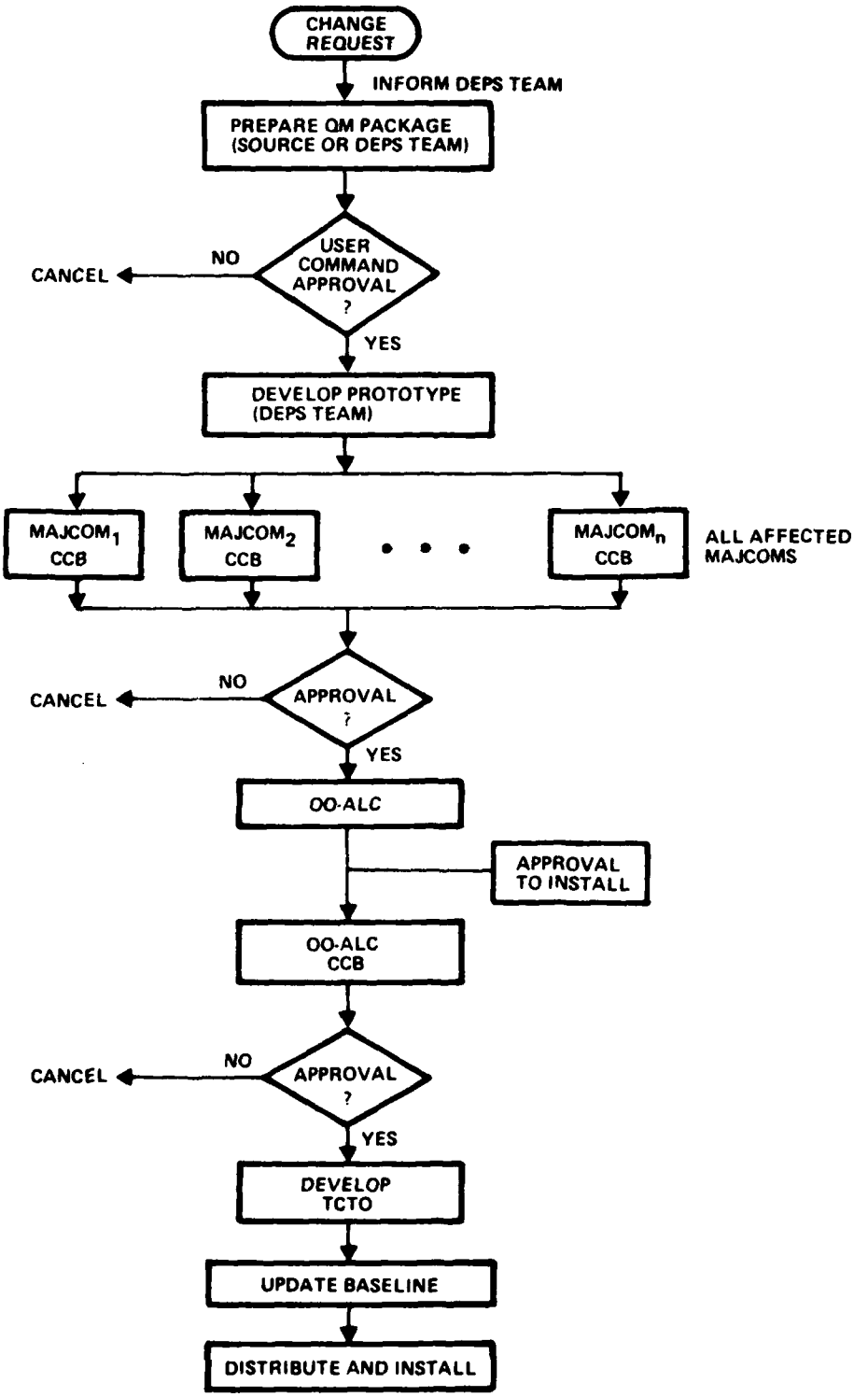


Figure 3-2. Quick Modification Process

to other sites because the DEPS has the equipment and capability to duplicate the necessary media. Figure 3-3 is a diagram of the process taken from the QM memorandum of agreement, and applies to both hardware and software quick modifications.

A variation of the concept for the Ogden ALC phase of the organic update process for software-only modifications is shown in Figure 3-4. After the DEPS team sends the QM package to Ogden, the Trainer Division receives it, reviews the data, and compares the changes to the baseline. Upon satisfactory review, approval for the DEPS to distribute the patch is given. The actual baseline, under Ogden configuration management, is left unchanged. When a group of ten changes are assembled, or if less, a year has passed, CCB approval is sought. If CCB approval is given, the baseline software and the documentation is updated, TCTO's are prepared, and the new source deck baseline program is distributed. ATC and MAC are currently using these procedures, and they are anticipated to soon be in general use.

3.3.2 Contractual Modification Process

When a modification requirement is beyond the means of the DEPS team, it is procured from a capable contractor through the system manager or an item manager, if appropriate.

Contracting for a modification to the ECS is similar to contracting for other supported systems. An ECP is prepared describing the change requirements and potential suppliers are notified. Information for the ECP may include contributions from the team supporting the affected DEPS or from the primary weapon system SM, as well as the ATD, SM, or IM.

Contracted changes requiring an ECP are usually performed by the contractor who built the trainer. Terms, schedule, and cost to buy the update are then negotiated. The contractor performs the engineering analysis and design and defines acceptance test procedures. He then installs and debugs a protytype normally at the DEPS site with

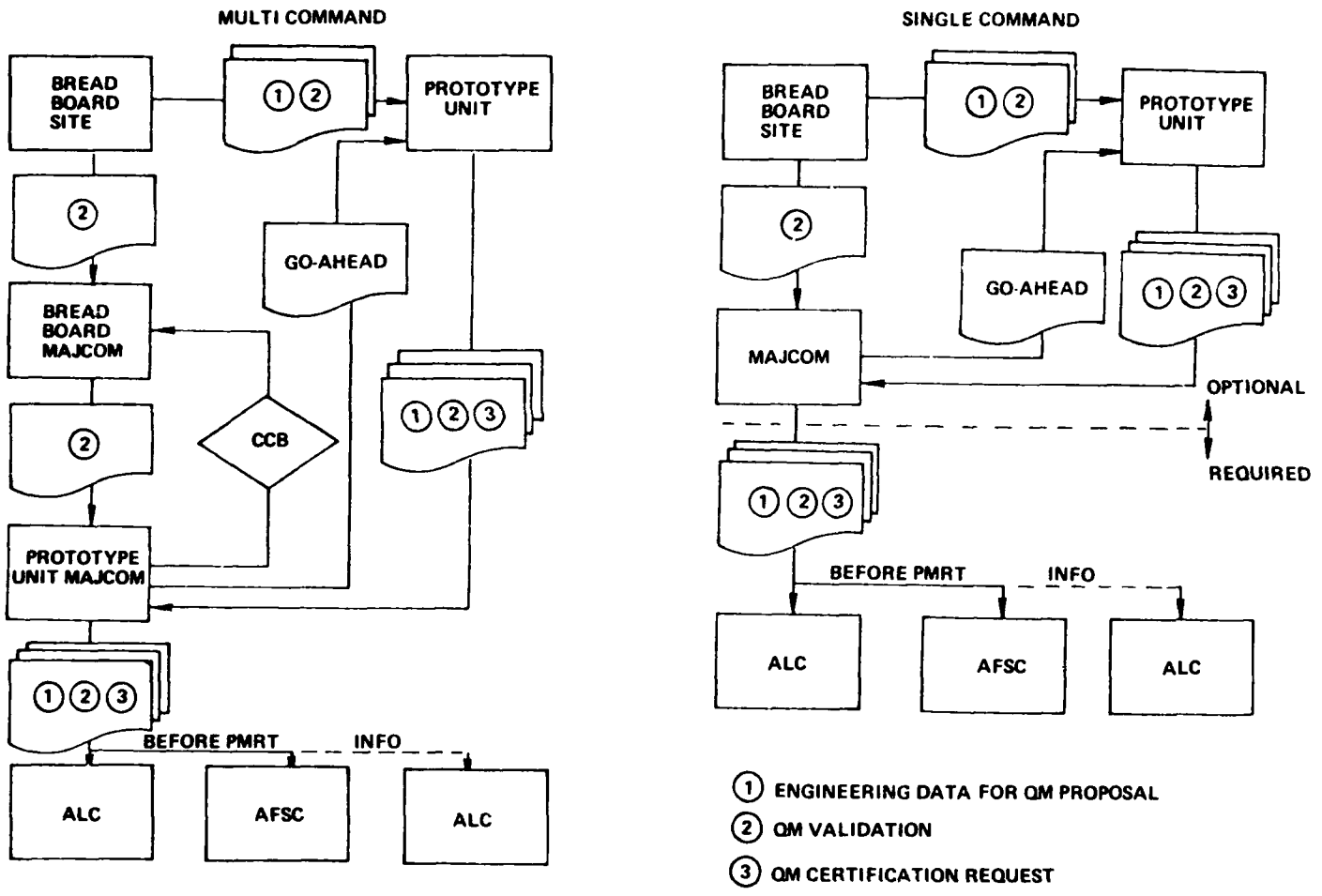


Figure 3-3. ATD Quick Modification Flow

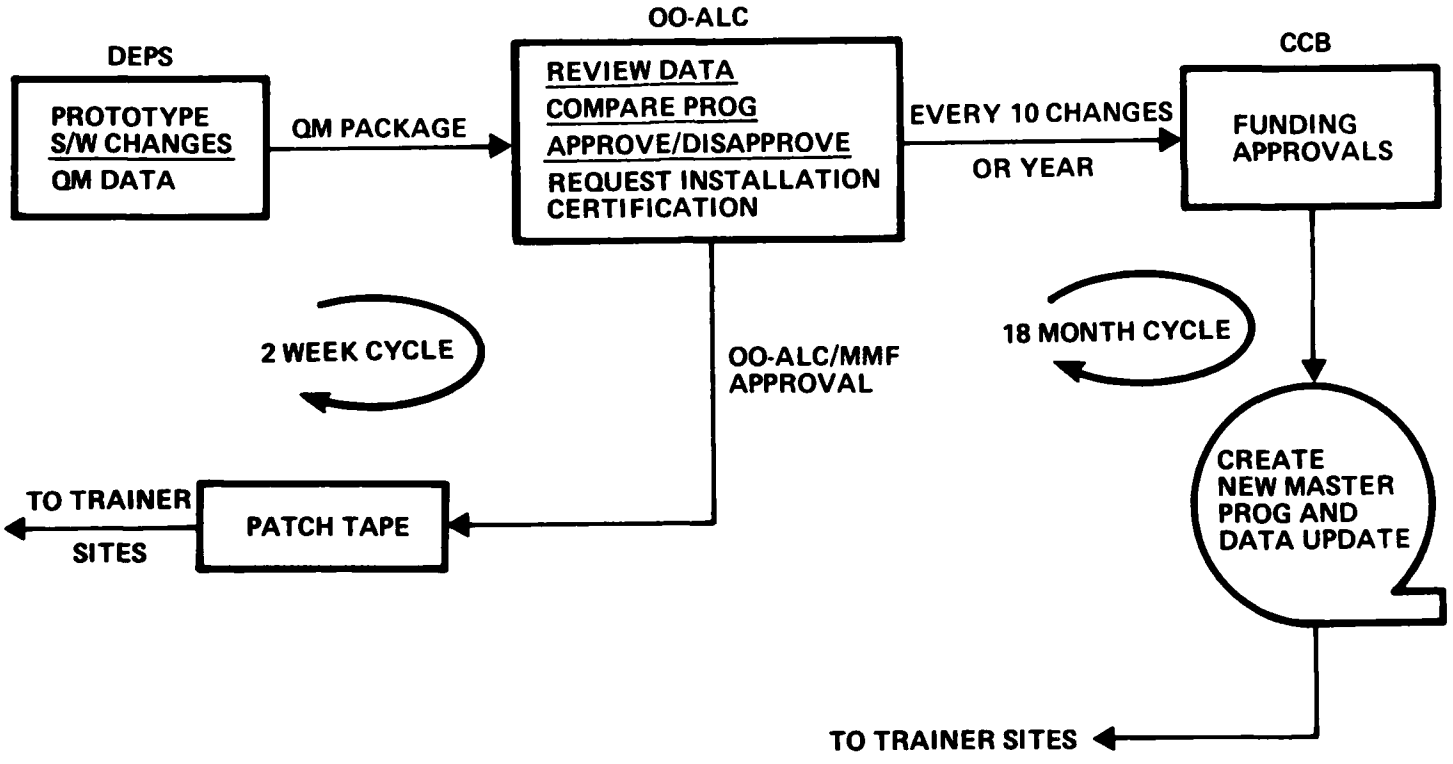


Figure 3-4. QM Software Update Process

the DEPS team participating in acceptance testing. After prototype acceptance testing, the contractor prepares modification kits and writes a redline TCTO defining kit installation procedures. The DEPS team participates in kit proofing of the TCTO procedures. Production articles are accepted by Form 82, which lists any deficiencies, and the contractor publishes the final TCTO and installs the remaining kits.

Protype acceptance and kit proofing are the responsibility of OO-ALC, who may delegate the responsibility to the user. Trainer operating personnel (using command pilot, instructors, and/or maintenance personnel, as appropriate) verify the modifications when installed. Further validation consists of testing in usage only.

These two parallel paths, organic and contracted, are primarily independent. The DTT responds to change requests with its quick modifications, while the ALC is contracting for unrelated change developments. To prevent duplication of effort, when a contract is awarded the baseline is frozen and generally no new DEPS QM development is authorized against the old baseline. However, there have been instances of duplication of efforts in the past. The various DEPS have initiated QM development only to learn that the ALC had already contracted for that modification. This type of problem, regardless of which organization is responsible, illustrates a lack of communication. Two circumstances exist in which duplication of effort is the result (perhaps necessarily) of procedures. When a contract is let for ATD modification, a baseline system from which the modifications are to be developed is specified. Some QM's for which approval has already been given may not be sufficiently developed to be included in the contractual baseline. In most cases, these modifications are completed and installed, then must be reinstalled on the new baseline. Also, QM's considered to have a sufficiently high priority may be approved for development and installation on the old baseline, then reinstalled when the new baseline becomes available.

3.4 SPARES SUPPORT CONCEPT

Spares support provided under the system manager/item manager philosophy. Most ECS in training devices are classed in Federal Supply Group-70 (FSG-70). The item manager for FSG-70 who supports the ECS hardware and, usually, vendor-supplied software is at Warner Robins ALC. Executive and library software are usually maintained by the IM or procured from the vendor. Non-ECS hardware elements in a given ATD are supported by the appropriate item managers.

4. REPRESENTATIVE ATD SYSTEMS

Since the purpose of studying representative systems is to infer how ECS support is currently implemented across the ATD category, the representatives must present a cross section of parameters of concern. The four DEPS chosen to represent this category take into account the dimensions of user command, point in the life cycle (maturity), device complexity, computer characteristics, and number in use.

Table 4-1 shows the representative systems and their characteristics. The DEPS chosen (F-4C, F-15, B-52, and C-141/C-5A) span the operational commands, include older, current, and near-future trainers, and utilize a wide variety of ECS hardware.

4.1 F-4E DEPS

The F-4 series of fighter aircraft are supported by a corresponding series of aircrew trainers. The aircraft versions with currently deployed trainers are summarized in Table 4-2.

The F-4E weapon systems trainer was chosen for study because it is representative of an older application of ECS to trainers, how additional ECS are added on for enlarged capability, TAC as the user command, and support to one trainer in a family of related trainers.

The first F-4E trainer was built in the early 1960's using a General Precision GP-4 computer. Sixteen of these were deployed and are in service at various training locations. At various times, additional equipment has been added until there are now four different computers integrated into the trainer performing real time functions. At each expansion of ECS, different computeres were selected.

At the present time, the F/RF-4C and F-4D versions of the ATD's are still analog, although SEL 32 series computers are being procured for incorporation in these trainers. A SEL 32/75 will be used as a

Table 4-1. Representative System Characteristics

ATD	User Command	DEPS Location	Status	Computer Characteristics	Quantity	Comments
F-4E Weapon System Trainer	TAC	Luke AFB	Transitioned	SINGER GP4B (144K) Data general NOVA's IMLAC PDS-4	16	• Older system • Multiple ECS with add-ons • Part of F-4
F-15 Mission Trainer	TAC	Luke AFB	In acquisition PMRT 1982	3 Harris 6024/4	13	• ECS similar to AISF
B-52 Weapon System Trainer and Flight Simulators (B52-G)	SAC	Castle AFB	In development Transitioned	Harris 6024/5 GA SPC 16/60	2	• New acquisition • Train 6 crew members
C-141/C-5A Flight Simulators with Visual System	MAC	Altus AFB	Transitioned	SEL 840's TI 980 CDC 924	6	• Integrated 2-system support

Table 4-2. F-4 Series

Version	Use	GEPS
F-4C	Fighter	Luke
RF-4C	Reconnaissance	Luke
F-4D	Fighter	Luke†
F-4E	Fighter	Luke
F-4G	Fighter	George

† The trainer prototype is at Nellis AFB.

DEPS support computer. The F-4G DEPS, active since November 1979, is independent of the F-4E DEPS and not covered here.

The primary weapon system is the F-4E aircraft. Each of the F-4 versions is similar to the others, with the later revisions representing major Class V modifications. For aircrew training purposes, there is a strong similarity, particularly in the area of simulating the aircraft performance.

4.1.1 Organization

The commands using the F-4E trainers are TAC, USAFE, and PACAF. TAC has the central role with regard to support and is the operator of the CONUS F-4E training sites. Within TAC, responsibility for ATD support is assigned to TAWC (Eglin AFB). The TN office in TAWC is divided into TNA and TNS, primarily supporting air-to-air and air-to-surface combat aircraft, respectively. The F-4E Development Technical Team (DTT) is the DEPS support team reporting to TAWC/TNA, as shown in Figure 4-1.

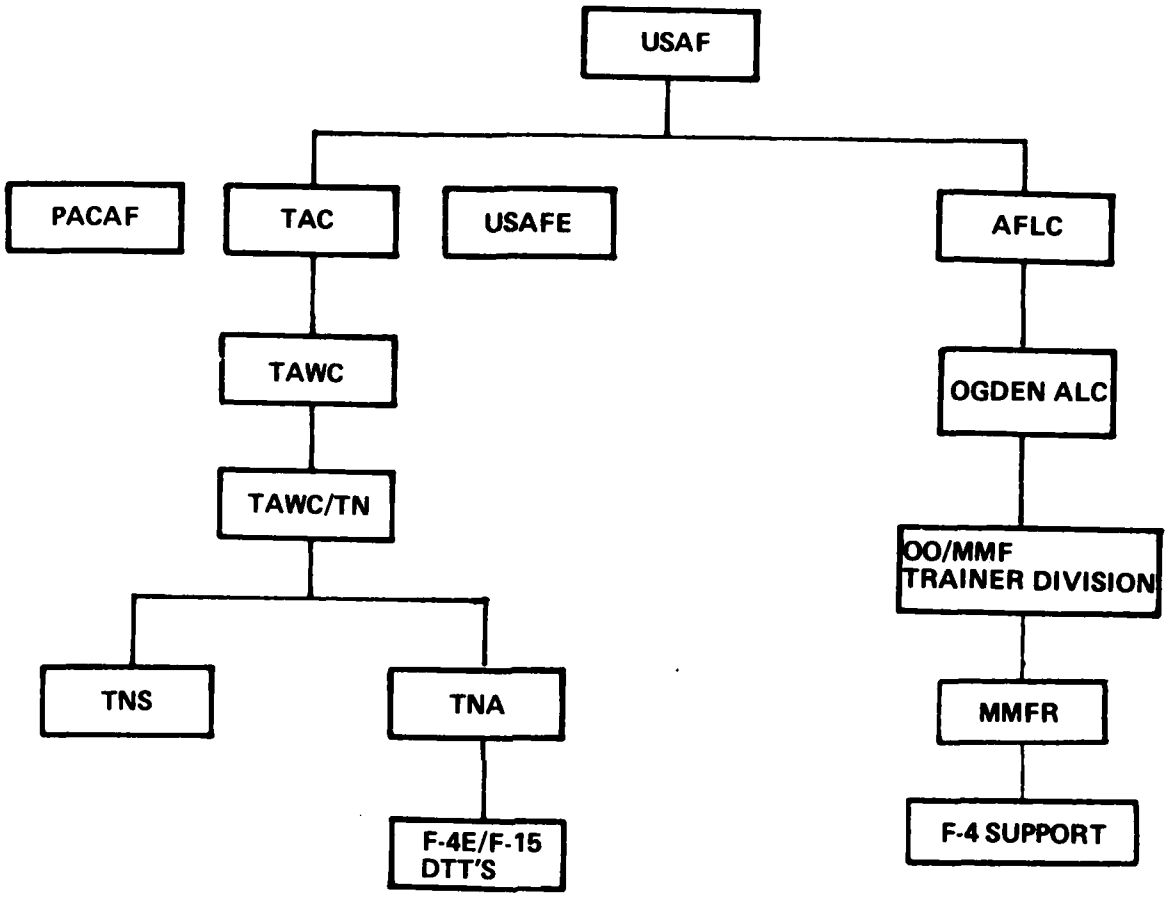


Figure 4-1. Organizational Relationship of OO-ALC/MMF to F-4/F-15 DEPS

The F-4E DEPS is located at Luke AFB, AZ, one of the TAC training sites. The DTT support role is strongly differentiated from maintenance, which is performed by the wing. The support role is to create and evaluate changes to the trainers, hardware, ECS, and support systems included.

Ogden ALC provides logistics and engineering support in coordination with TAWC. In the past, there has been an on site OO-ALC representative. The position is currently vacant. OO-ALC is attempting to hire a replacement engineer to fill the slot. The previous resident engineer had performed as if he were distinctly separate from the DTT. There are seven members of the DTT, six military and one civilian. Members are volunteers from within the Air Force for a typical six-year tour of duty.

Because of the similarity of the F-4E trainers to the F/RF-4C, and F-4D versions, the same DTT also supports these models at Luke AFB for the F-4C and at Nellis AFB for the F-4D.

4.1.2 Equipment

The current trainer consists of the following main elements

- Pilot cockpit
- Visual display system
- G-suit
- Instructor console
- Recorder console
- Simulation computer (GP-4B)
- Automated adaptive flight training system
- Radar land mass complex
- Signal distributor

The signal distributor provides cable interconnection between the various subsystems. The instructor has control of the mission from his console and can use canned flight scenarios from the automated adaptive flight training system.

The current configuration of the F-4E trainers has evolved by first converting the simulation function to digital (circa 1968). Additional capabilities were added until the present configuration, summarized in Table 4-3, evolved.

Table 4-3. F-4E Mission Simulator

Simulator	Computer	Function
Mission Simulator	General Precision GP-4B	Control computer Dynamic simulation Motion system (disabled) Target generator
Adaptive Flight Training System	NOVA 3/12 NOVA 3D IMLAC PDS-4	A/A scenarios A/G scenarios Scoring system
Day/Night Visual	Varian 76	Display generation and control

The GP-4B is a special purpose computer supported by Ogden ALC. The other ECS are standard computer hardware, maintained and supported by Warner Robins ALC as Federal Supply Group 70 (FSG-70) equipment. Support includes executive and other vendor-supplied software.

4.1.3 Support Operation

4.1.3.1 ECS Changes

Potential changes identified by the using command are brought to the attention of the DTT which assigns a number and logs the item. The DTT performs a preliminary evaluation to validate the change and determine the nature of work (hardware vs software).

When the aircraft configuration is changed, such as by the current upgrades to digital avionics, the ATD system manager (MMF) is notified and MMF is then responsible for the change. These are usually (but not always) extensive modifications developed by a contractor. MMF budgets and schedules resources required for the modifications.

4.1.3.2 Change Development

Organic changes are created at the DEPS by the DTT under the QM Concept (see AFR 57-4). If no hardware changes are required, the DTT performs the analysis, designs the change, codes, installs, checks, and documents it. If minor hardware changes are required, hardware is supplied by the using command. If major hardware changes are required, an ECP is prepared and Ogden is requested to buy the appropriate hardware. Ogden ALC has approval authority for quick modifications. In practice, their function is to evaluate the modification desirability, and to determine if all necessary activities have been performed and the proper documentation is supplied. They do not perform a detailed engineering evaluation of the change.

The DTT has identified 202 QM's over the eight years of QM usage (about 25 per year), although there is a wide breadth of effort required between the simplest and the most demanding modification. Through November, there were eight QM's completed in 1979, and the backlog was 53 more.

Due to the frequency of modifications on this system, there is not a reliable baseline. DEPS personnel expressed concern over the need to reinstall some of their modifications when the contracted baseline was updated.

4.1.4 Near-Term Planning

Currently, the largest impending change for the F-4E aircraft is the digital avionics upgrades which will require a major update to the trainers. The F-4E (and RF-4C) aircraft will receive the ACM,

ARN-101, and PAVE TACK updates and the trainers must be modified to match. At the time this report was generated, no F-4E concurrency changes to the ATD were underway. However, a Program Management Directive (PMD) is in existence which requires four of the F-4E ATD's to be upgraded to the F-4G configuration.

A second need is to replace the aging General Precision GP-4B embedded computers which have insufficient capacity for compatibility with the digital avionics upgrades and which have maintenance problems. This will require hardware replacement, some interface reengineering and the replacement and rehosting of the application software. In addition, all outstanding modifications may be picked up to create a clean, up-to-date baseline.

4.2 F-15 SUPPORT

The F-15 trainers are operationally deployed, but the primary management responsibility still resides in the procuring SPO (F-15 aircraft). The F-15 contains a large digital avionics suite, requiring many updates to be reflected into the ATD. It is also the last trainer procured by the aircraft SPO, pre-dating the formation of the ATD SPO in the Aeronautical Systems Division of the AFSC.

The F-15 aircraft is a high performance fighter aircraft performing in a variety of air-to-air and air-to-ground warfare modes. Thirteen crew training simulators, built by Goodyear Aerospace Corporation, have been ordered and the first seven have been delivered. First delivery was in 1976. The DEPS location is Luke AFB, where two of the first seven are deployed. PMRT of the trainer is currently scheduled for October 1982. Ogden ALC plans to assign one resident engineer but the position is currently vacant.

4.2.1 Organization

Program management responsibility for the F-15 ATD resides at the F-15 SPO. The original contractor, Goodyear Aerospace, is under

contract to the SPO to support the trainer, including the embedded software. Changes to the Harris computers and their support are the responsibility of Warner Robins ALC, who contracts with Harris. Ogden ALC is not yet providing a DEPS engineer but plans to do so prior to PMRT.

The F-15 trainer is assigned to Ogden ALC for system management and is operated by the 405th tactical training wing, stationed at Luke AFB, who use it in training flight personnel. TAC support responsibility resides in TAWC/TNA at Eglin AFB, FL. TAWC has assigned a Development Test Team (DTT) which resides at the DEPS to support the F-15 trainers and TAWC/TNA. These organizational relationships are shown in Figure 4-1. The DTT will not perform software support functions involving modifying the system prior to PMRT. It has been reviewed in R and D testing as well as operational support since the trainers were delivered. Members have also attended design review meetings in support of the SPO. These activities are intended to educate the DEPS team so they can provide quick modification support after PMRT.

4.2.2 Equipment

The current trainer consists of the following main elements

- Pilot cockpit
- Motion base system
- G-suit system
- Instructor console
- 3 Harris 6024/4 computers

The G-suit system will be used to give the pilot the feel of motion, and use of the motion base system installed on simulators 1 through 7 will be discontinued and removed. Units 1 through 7 include paper tape punch and readers; later units will have magnetic tape capability. It is planned to retrofit the first units to magnetic tape in the future.

The computers are in the same family as those installed in the F-15 AISF at Warner Robins and functional assignments between the individual processors are similar. There has been some sharing of information between the AISF and the DEPS, particularly in modeling simulated functions. The only ATD software used intact in the AISF is the tabular aerodynamic data, and the central computer emulator.

ECS support software includes Harris-supplied cross reference generator, assembler, and debug package. Units 8 and on will have additional debug capability.

4.2.3 Support Operations

4.2.3.1 ECS Changes

The trainers are in operational use, and trainers and instructors orginate some change requirements. Roughly 80 percent of changes to the F-15 ATD are concurrently reported due to aircraft configuration changes and the other 20 percent are due to simulator corrections and upgrades. Changes are identified by ECP.

4.2.3.2 Change Development

All changes are now being made by the contractor. The DTT is involved in reviewing ECP's, initial acceptance of the modifications, and final checkout. The contractor is expected to continue to develop all changes until the DTT is prepared to organically perform the function, probably after PMRT in 1982. After that time, the DTT expects to develop a significant portion of the changes (items) and have a contractor develop the remainder. Changes to the Harris computers and their executive software are the responsibility of Warner Robins ALC, who may contract to Harris.

4.2.4 Near-Term Planning

The F-15 mission simulator is in the late state of acquisition. Efforts on the program are being devoted to getting all the units delivered,

installed, and operational while correcting and improving the configuration. Preparations for PMRT are under way at Luke AFB and at Ogden ALC. The DTT is preparing to provide support organically following PMRT. No significant changes to the trainer ECS configuration have been identified.

4.3 B-52 AND H DEPS

The B-52 is one of the oldest operational aircraft in the USAF inventory. The weapon system has gone through many upgrades and a new digital avionic system is now in acquisition.

The current B-52 ATD's were chosen as a representative system to include SAC as a using command, a large crew (six members), and a strategic bomber mission. The Weapon System Trainer (WST), which is in the early stage of acquisition, and the operational flight simulators are the trainers chosen. At the time of creating this baseline, the WST award is in the contractor selection phase, limiting the available information. Recently, a B-52 air-to-air refueling part task trainer and a KC-135 boom operator simulator were added to the Castle AFB DEPS inventory.

B-52's have been deployed since 1952. Versions currently in use are the -D, -G, and -H. There are flight simulators to train the pilot and copilot for each version in use. The DEPS is at Castle AFB, CA, the Combat Crew Training School (CCTS) location for the -G and -H versions. The CCTS for the -D version is at Carswell AFB, NM. In addition, there are B-52 EW and Tacan station trainers.

At this time there is a Class V modification program to add a digital avionics, the offensive avionics systems to the -G and -H versions, and digital bomb navigation system to the -D version.

These trainers will need to be modified to reflect this new equipment, which will require more DEPS support than the current analog avionics. In addition, when the new WST is deployed it will greatly increase the ECS support work load. The WST will employ numerous programmable digital processors in a single training device which can allow simultaneous operation of all six crew stations in one exercise.

4.3.1 Organization

Strategic Air Command is the user command and operator of the trainers. Logistics is the responsibility of Ogden ALC. The simulator SPO in AFSC/ASD is responsible for acquiring the weapon systems trainer. In SAC, trainer support is the responsibility of the 4200 Test and Evaluation Squadron (TES). The group performing support is referred to as the "DEPS team", which is a detachment of the 4200 TES. The key members of the team have all been involved with aircrew trainers for extensive periods (twelve to nineteen years). The members have received most of their digital system, hardware, and software training by military courses, with some outside college training.

Ogden ALC has assigned logistics support to the ATD system manager, MMF. There is one OO-ALC engineering representative at Castle AFB, who works directly with the DEPS team. This representative has been there for three years, with pertinent aircrew trainer engineering experience prior to that time.

The working relationship between SAC and AFLC is defined by a SAC-AFLC Letter of Agreement, dated 15 April 1977. According to this letter, the main function of the ALC representative is to keep AFLC agencies "abreast of the SAC simulator program progress".

Operations of the trainers are under the control and schedule of the base wing. Maintenance and support requiring access to the trainers need to be coordinated with the wing.

4.3.2 Equipment

The primary ECS support efforts at the B-52 DEPS are for the current B-52G/B-52H flight simulator and procurement support to the simulator SPO in ASD for the weapon systems trainer. Table 4-4 summarizes those ATD supported that contain embedded computers.

Table 4-4. B-52 DEPS Trainers

Simulator	Embedded Computer	Functions
B-52G Flight Simulators	(2) Harris 6024/5	Flight trainer for pilot/copilot
B-52H Flight Simulators	(2) Harris 6024/5	Flight trainer for pilot/copilot
B52 Air-to-Air Refueling Part Task Trainer	(1) Harris	Pilot trainer for refueling operations
KC-135 Boom Operator Part Task Trainer	(1) Harris	Boom operator trainer for refueling operations
B-52 EW Trainer	General Automation SPC 16/60	EW officer trainer
B-52 Weapon System Trainer		Trainer for entire B-52 aircrew

These flight simulators were originally built by Curtis-Wright as analog systems, then converted to digital. These three at the DEPS are the only three that were converted. Major elements are:

Cockpit model (pilot and copilot)

Instructors console

Dynamic simulation

Other training locations have the original analog version upgraded with a "Tacan Mod", also analog. Since there are no ECS, these are not covered further.

At the DEPS, support is performed on the embedded computers directly. The DEPS contains an area for use and storage of card punch, paper tape, and magnetic tape read, write, and copy devices from General Automation and Univac. Backup versions of the programs are stored on card in card files.

4.3.3 Support Operations

4.3.3.1 ECS Change

Software change proposals are generated by the operational users of the trainers, the aircraft systems manager at Oklahoma City ALC, the ATD Manager at OO-ALC, the hardware IM, or by SAC Headquarters. Usually, the operational users report change requests to the DEPS team by letter. The team forwards change requests to SAC and in turn to OO-ALC, while the SM/IM or SAC Headquarters reports them to Ogden ALC.

The DEPS team receives and logs the requests for changes. There is a Simulator Software Working Group (SSWG) which performs the log keeping function, consisting of DEPS team members working on ECS software plus the Ogden ALC resident engineer. When a change proposal is presented to the DEPS team, it is evaluated for feasibility,

usefulness and resources requirements to implement. It is then brought to the SSWG for approval and the group recommends the priorities of the various pending change proposals. The priorities are published in the SSWG minutes (quarterly) and submitted to SAC Headquarters for approval or revision. When approved, the change is developed at the DEPS. MMF approval is required for installation.

4.3.3.2 Change Development

Changes may be developed organically at the DEPS or by a contractor.

4.3.3.3 Organic Change

Members of the DEPS team specialize in supporting one training device. Change requests are assigned to these personnel on a team basis for analysis, design, and code. They also perform integration and checkout tests. When the team feels that the design requirements have been met satisfactorily, the modifications are ready for final testing. This step is comparable to acceptance testing or independent validation. It is performed informally by maintenance, flight crew members, or trainer instructors, as appropriate to determine if the change meets the purpose and need for which it was intended.

The software baseline configuration management is the responsibility of OO-ALC. The DEPS team uses a copy of the software baseline as its reference program. Trail changes are added to create a development package or test version of the program. When tests are complete, the SSWG submits a request for approval to SAC HQ. When received, a new operational baseline program consisting of the software media baseline plus all SAC/ALC-approved modifications is made and distributed to all trainer sites.

The software media baseline is not updated without Ogden approval. The method used to get Ogden approval is similar to that described in Figure 3-2 for block change updates. When a group of changes has been

completed, they are submitted in batch to Ogden for review and CCB approval. Then Ogden ALC, which is responsible for configuration control, can update the documentation and media baseline and release it as the new baseline version. To date, this has been tried with one batch of B-52G and B-52H CPT changes. Eighteen months is the normal processing time for ATD baseline changes. Nine months are typically required for ALC review and contractual action, and another nine months for the contractor effort.

During the DEPS activity, the Ogden representative is responsible for communicating with the ALC. He also stores the master copy of the software media. This is an important role in the configuration control process, but is subordinate to the configuration management function of the ALC. The OO-ALC representative is the only person who modifies the baseline software to create a new working (operational) version.

4.3.3.4 Contractor Modifications

When hardware is involved or the change request is directed to Ogden, the ALC lets a contract to buy the modification, usually from the same contractor who developed the trainer. Each time the contractor is given the software baseline program to work from. If, as is usually the case, the operational version is different than Ogden's baseline, the final product delivered is incompatible with the operational version. The DEPS team must then reinstall all modifications pending since the last baseline, and those modifications remaining outside the newly-bought baseline. Reasons for these B-52 baseline differences are the same as those discussed in Section 3.3.2.

The organic and contractual update processes are independent and simultaneous. Communication consists of SSWG status reports, ALC status reports, DEPS/SAC letters and informal means.

4.3.4 Near-Term Planning

There are no large significant changes or additions to the support of the current B-52 ensemble of trainers.

The planning for the B-52/KC-135 weapon system trainer occupies a significant amount of effort for the 4200 TEST detachment. Although the procurement is at the very sensitive stage of source selection, certain impacts on ATD support are evident:

- The DEPS team has stated that there will be a request for three Ogden ALC representatives instead of one.
- The WST will be more complex than any current system, with multiple tasks being trained at one time, a large number of distributed embedded computers, and other complications induced by the size of the trainer.
- The increasing demands on ECS software guarantee greater reliance on the ability to modify and support software.

4.4 C-141/C-5A FLIGHT SIMULATORS

The support center for the C-141 and C-5A ATD's is at Altus AFB, OK. The support of these systems is partially integrated, reflecting the operational similarities of the aircrew procedures. The DEPS is manned by the Military Airlift Command without an ALC engineering representative, since HQ MAC has not requested one. As a representative system, it presents MAC operations, cargo aircraft, and a mature operation.

The C-141 was the earlier digital aircrew trainer. It had a Singer Mark I drum computer in the original Singer-Link version, which was replaced by the SEL in 1969, at about the same time the C-5A Trainer was installed. Visual capability was added to both trainers in 1974.

Additional computers have been added or replacements made until the current configurations were reached. Additional software support center requirements were realized and equipment has been purchased since 1974.

Training for both aircraft (C-141/C-5A) in one center takes advantages of key similarities between the two aircraft. Both were built by Lockheed, and although there is a size difference, both have many of the same or similar subsystems. Perhaps most important, their functions and cockpits are very similar. At Altus AFB, both trainers are located in the same building.

4.4.1 Organization

Support of the ECS is provided by MAC personnel in the 443 AMS/AAD at Altus AFB. The branch chief refers to the support personnel as the "DEPS team". Ogden ALC does not have a representative engineer attached. The DEPS team interfaces with:

- MAC HQ/LGMA
- Aeronautical Systems Division
- Contractors
- Ogden ALC

Support to ATD ECS is the responsibility of the DEPS team, although there is extensive contractor involvement.

Members of the DEPS team are enlisted men or civil service with varying levels of experience. Initial assignments are to work on one system, then expansion. In general, these members have long trainer experience. Senior people, having mastered one device, are then trained on the other. The result is flexibility to adjust senior personnel assignments to work loads.

Control of the non-Altus sites is not under the DEPS team, but under the wing commanders.

4.4.2 Equipment

At Altus, there are two C-5A mission simulators that are used to train the four man crew. Capabilities include simulation of radar and weather signals, although these are analog driven. There are four

computers currently embedded in these ATD's, including the visual system. The allocation of functions is summarized in Table 4-5. There are three more units at other sites.

There are actually two versions of the C-141 flight simulator, a Link version and a Curtis-Wright version, with one of each at Altus. The two versions have different hardware and software. There are a total of 6 Link and 2 Curtis-Wright units. The computers are shown in Table 4-5.

The visual system is common to all trainers. At Altus there are only two visual systems to be shared between the four units. ECS is a TI 980B for all units except those at Altus, but those are being converted from SEL 840's to the TI's.

The TI 980B in the visual system is used to support software modifications and analysis. Peripherals and support equipment were received with the system, giving Altus a software support center capability. A year later, they acquired a CDC 924 and related peripherals for added capability.

The operational trainers are used for support, also. The center is now in a reduced training environment, running lessons six days each week and 12 to 16 hours per day, with eight hours each day and the entire seventh day set aside for maintenance and support activities. Most of this time goes in maintenance. Available time is especially short on the C-5A trainers.

Some of the ECS hardware, primarily the SEL and TI 980 computers is common to both trainers. This gives the DEPS Team an advantage, particularly in software commonality.

4.4.3 Support Operations

4.4.3.1 ECS Changes

Most changes are in response to aircraft changes. The C-141, the older plane, is having trouble maintaining its equipment baseline

Table 4-5. C-5A and C-141 ECS Functions

Simulator	Embedded Computer	Function
C-5A	SEL 840A	Master computer
		Timing control, interrupt control
		Models of hydraulic, electrical, and most other aircraft systems
	SEL 840MP	Models flight, aerodynamics, radio aids, navigation
	TI 980B	Triple-redundant navigation
		INS
		CRT driving and instructor station
		Malfunctions
C-5A/C-141 (Dual Usage)	TI 980B or SEL 840	Visual systems
		Either trainer
		2 shared for 4 trainers at Altus
		1 to 1 at other sites
		(SEL 840 at Altus only)
C-141 (Link)	SEL 840 MC/MP	Executive
		Dynamic simulation
		Stimulate cockpit displays
		All others
	TI 980	Inertial navigation system simulation
		CRT displays
		Keyboard input processing
C-141 (Curtis Wright)	CDC 924 (two each)	Executive dynamic simulation
		Stimulate cockpit displays
		All others
	TI 980	Inertial navigation system simulation
		CRT displays
		Keyboard input processing

because many of the original design components are no longer manufactured and spares are unavailable. These are being replaced by new versions or equivalents that need to be modeled in the ATD's.

The second source is the response to incidents or accidents that occur in flying operations. When these occur, the trainers are modified to allow the simulation and reconstruction of the event as an aid to analysis and development of the fix, or new crew procedures.

4.4.3.2 Change Development

The DEPS team has the capability to develop changes, or a contractor may be given the task.

Changes identified first to the DEPS team are usually developed organically. Software changes are developed by a group of only six team members who have the capability. The DEPS team analyses, designs, and codes the changes, then performs checkout on the trainer prototypes. Flight crews, instructors, and/or maintenance personnel, as appropriate, are used for testing of the changes.

When Ogden receives the initial request for a change, the DEPS team is informed. If the change is not beyond the DEPS capacity, it will be assigned there for development; otherwise, Ogden ALC will contract for the development. Conversely, if the effort required for a change or the cumulative work required for a group of changes exceeds the capacity of the DEPS team, then Ogden ALC is requested by the team to contract for the effort.

Ogden ALC maintains configuration management of the documentation, whereas the Altus DEPS team maintains the computer programs.

New computer programs for the C-141 trainers are distributed on floppy disk. C-5A trainer programs are distributed on magnetic tape.

4.4.4 Near-Term Planning

A new C-5A cockpit trainer is being acquired with attached software support center equipment. This will give the DEPS team expanded capability to support trainer software.

4.5 ANALYSIS OF SUPPORT POSTURE

Four representative systems were studied to determine a representative ATD support posture. The individual support postures are summarized in Table 4-6. In this subsection, the ATD support posture is analyzed, considering the requirements of Section 2, based on the data collected from the four representative systems. The following general points are presented.

- The ECS in ATD's are currently supported in an active manner. The level is adequate in that the trainers are kept operative and in use, and serious complaint by the MAJCOM's generally does not occur. However, there are several problems which are discussed in Section 5.3.

- Comments on the eight ATD support requirements versus posture are presented below.

  1. ECS change requests come from a variety of sources but principally the system manager and the user. The ALC and DEPS teams attempt to communicate on change request status with varying degrees of success. Although means of communicating approval of DEPS and contracted changes are in place, some DEPS team members stated that in the past they have worked on changes which had already been contracted without their knowledge of the contract. They also stated that communication is improving.

  2. The ALC relies on contractors or DEPS for most specifications. The DEPS teams without an ALC engineer have a technician's level of capability to define change specifications. With the engineer, the capability is increased, reducing the need for contractor involvement.

     CPCI Part I Specifications, if ever produced, are not maintained after PMRT, because there is no anticipated requirement for follow-on procurement of additional trainers. Change specifications therefore must relate to "what's there" rather than to an up-to-date Part I Specification.

Table 4-6. ATD Representative System Support Posture Summary

ESC Support Requirements	F-4E (Luke AFB)		F-15 (Luke AFB)	B-52 (Castle AFB)		C-141/C-4A (Altus AFB)	
	ALC/Contractor	DEPS Team		ALC/Contractor	DEPS Team	ALC/Contractor	DEPS Team
	Organic	Organic	All	Organic	Organic	Organic	DEPS
1. ECS Change							
1.1 Receive and Process Requests	From F-4 SM	From users and TAC, PACAF, USAFE	All changes to F-15 SPO, Trainer office	Aircraft SM, SAC Hq.	From flying crews, instructors, maintenance, SAC Hq, EW SM	From aircraft SM	From flying crews, instructors maintenance, result of incidents
1.2 Preliminary Analysis and Problem/Deficiency Definition	By F-4 SM	DTT	All changes by contractor	Originator	Originator or DEPS team	Originator	DEPS team
1.3 Preliminary Resource Allocation and Scheduling	All	DTT	F-15 SPO	ALC	DEPS team (SSWG)	ALC and DEPS team	DEPS team
Comments			Pre-PMRT		Approval at SAC Hq.	If possible, assigned to DEPS team	Approval at MAC Hq.
Per Concept	Yes	Yes	*	Yes	Yes	Yes	Yes
2. Change Analysis and Specification	F-4 SM or contractor ALC writes contract	DTT	F-15 SPO contracts	ALC contracts DEPS team reviews	Software only	ALC contracts DEPS team reviews	DEPS team
2.1 Feasibility	Contractor	DTT		Contractor/DEPS team	DEPS team/may request ALC to contract	Originator, contractor	DEPS team
2.2 Requirements Decomposition/Definition	Contractor	DTT					DEPS team
2.3 Preliminary Design	Contractor	DTT		Contractor or originator	DEPS team/originator	Originator, contractor	DEPS team
2.4 Detailed Design	Contractor	DTT		Contractor	DEPS team	Contractor	DEPS team
2.5 Generate Change Proposal	Contractor/ALC or originator	DTT to TAC Hq.		Contractor/ALC	DEPS team	Contractor/ALC	DEPS team
Comments			Pre-PMRT	DEPS supports	Software only	ALC actions DEPS team who interface with contractor	DEPS team
Per Concept	Yes	Yes	*	Yes	Yes	Yes	Yes
3. Engineering Development and Test	Contractor	DTT	Contractor	Contractor	DEPS team	Contractor	DEPS team
3.1 Develop the Change	Use ALC approved baseline	DTT	Contractor	Use ALC approved baseline	DEPS team	Contractor maintains technical data base	DEPS team
3.2 Perform Engineering Tests of the Change	Contractor		Contractor	Contractor	DEPS team	Contractor	DEPS team
Comments			Pre-PMRT				
Per Concept	Yes	Yes	*	Yes	Yes	Yes	Yes
4. System Integration and Test	Contractor/DEPS	DTT	Contractor/DTT	Contractor	DEPS team/users	Contractor	Organic
4.1 Test ECS System Performance	Contractor	DTT	Contractor	Contractor, acceptance test by DEPS team, flying crews, maintenance	DEPS team/flying crews, instructors, maintenance	Contractor, acceptance test by DEPS team, flying crews, maintenance	Organic
4.2 Test Weapon System Performance	Contractor/DEPS team/crew and instructors	DTT	Contractor/DTT	Contractor, acceptance test by DEPS team, flying crews, maintenance	DEPS team/flying crews, instructors, maintenance	Contractor, acceptance test by DEPS team, flying crews, maintenance	DEPS team
4.3 Develop Test Reports	Contractor	Crew, instructors, originator, DTT	Contractor	Contractor, if any	DEPS team	Contractor, if any	DEPS team, flying crews, instructors, maintenance
Comments	May not include latest DTT modifications	Require TAC CCB approval	DTT assist in testing		Basic for SAC CCB approval to install		
Per Concept	Yes	Yes	*	Yes	Yes	Yes	Yes
5. Change Documentation	Contractor/ALC	DTT/ALC	Contractor	Contractor/ALC	DTT/ALC	Contractor/ALC	ALC/DEPS
5.1 Document ECS Change	Contractor prepares, change descriptions, ALC publishes TCTO	DTT, ALC publishes TCTO	Contractor	Contractor	DEPS team ALC publishes TCTO	Contractor	DEPS team
5.2 Update ECS Baseline	Documents: ALC Media: Contractor and DEPS team	Documents: ALC Media: DTT create interim working baseline	Contractor	Contractor prepares, ALC publishes TCTO	DEPS team by ALC directive	Contractor prepares, ALC publishes TCTO	DEPS team inputs to ALC
5.3 Configuration Control (ECS Change and ECS)	ALC approves official baseline	ALC responsibility	Contractor DTT monitors results	ALC approves new official baseline	ALC responsibility DEPS team creates operational baseline	ALC responsibility, details assigned to contractor	ALC
Comments	Organic modifications need to be reinstalled	DTT create interim working baseline		Organic modifications need to be reinstalled		Organic modifications need to be reinstalled	
Per Concept	Yes	Yes	*	Yes	Yes	Yes	Yes
6. Certification and Distribution	All	DTT/ALC	Contractor/SPO/DTT	ALC/DEPS	DTT/ALC	Contractor/ALC	DEPS/ALC
6.1 Certify Documentation	ALC, CCB approved	ALC, CCB approved	F-15 SPO	ALC, CCB approved	ALC, CCB approved to update baseline	ALC, CCB approved	ALC, CCB approved
6.2 Distribute Revised ECS Data	Documents: ALC Decks: DEPS team	Documents: ALC Decks: DTT	F-15 SPO	Documents: ALC Decks: DEPS	Documents (Final): ALC, (Interim): DEPS team	Contractor	DEPS team
6.3 Provide Installation Procedures/Instructions	Contractor provided kit proofs	DTT	Contractor/DTT kit proofs	DEPS team kit proof	DEPS team	Contractor	DEPS team
Comments						Weak control over remote sites configuration	
Per Concept	Yes	Yes	*	Yes	Yes	Yes	Yes

* DEPS personnel are in training and do not assume responsibility for software support until PMRT.

3. There are no identified interior milestones during DEPS team development activities of any, including the most complex, modification programs.

4. Integration and test is the responsibility of the modification developer. On contracted modifications, the contractor is responsible for developing acceptance test procedures to reflect the current updates. On many ATD's the original acceptance test procedures are not updated. Instead, a new modification acceptance test procedure is developed by the contractor. Test requirements are often poorly defined and traceable to the acceptance test procedures.

5. Change documentation is produced at variable levels. On some contracted trainer updates, the only documentation is updated media and program listing.

   The documentation baseline has been lost on some ATD's in the past. The ALC is attempting to recover these baselines on the next major contracted modification.

6. Certification of DEPS modifications by the ALC takes about three months. Procedures are being developed to improve the response, with a goal of two weeks. Certification of contracted modifications occurs with DD250 signoff.

   Distribution and installation seem to be adequately handled.

7. Concurrency of ATD change to primary weapon system change normally does not exist. Delays of ATD configuration updates of several years are common. Contracts for ATD modification are normally not let until all primary weapon system modification data is received, which causes a delay of at least 18 to 24 months for the approximately 90 percent of concurrency modifications which have to be contracted. Sometimes the delay is longer than two years due to lack of immediately available funding.

8. Planning for replacement of commercial ECS when they have aged and are no longer economically supportable normally begins after support difficulties have occurred. Replacement funding may then take several years to obtain.

- TAC has in the past considered ATD's mission-critical, and has required blue-suit maintenance. They have reclassified ATD's as non mission-critical, will be contracting for maintenance support, and have agreed to decrease the number of authorized maintenance personnel from 600 to a minimum of 250. Because DEPS personnel are drawn from the best and brightest of these technicians, it is possible that the quality of TAC's DEPS staffing will be decreased by this reclassification. TAC may request OO-ALC to staff the F-16 DEPS with largely or all ALC personnel (up to 30). A mix of TAC personnel with several OO-ALC resident engineers seems to be a reasonable approach to the solution of the above problem.

- An interest in several ALC resident engineers has been expressed by SAC for the B-52 weapon system trainer DEPS.

- In many cases the ALC must contract with the system developer due to lack of an adequate baseline. The problem of making available adequate baseline documentation to allow the option of competitive procurement of ECS hardware and software changes has not been solved on many ATD's.

5. ASSESSMENT

Aircrew training devices with embedded computers are currently being supported by a combination of Ogden ALC and user command personnel under the DEPS concept. Hardware and system software are usually supported by Warner Robins ALC as Federal Supply Group-70 equipment. The preceding sections have discussed the ATD category support requirements, the support concept, and four representative ATD systems. In this section, a critical assessment of ATD ECS software support is presented.

5.1 ANALYSIS OF SUPPORT CONCEPT

The DEPS support concept is analyzed in this subsection to determine how the concept elements relate to the requirements of Section 2. The relationship of support concept to requirements is presented in Table 5-1. The DEPS concept takes advantage of certain elements of the support environment. These are:

- The ALC is equipped to provide the support elements of spare parts, contractor support, and engineering.
- The user commands are intimately involved in using and maintaining the equipment.
- Each ATD is too expensive and there are too few units of each type required to justify the procurement of one of each type for a support center at the ALC.

The results of the study indicate that the DEPS concept has the following strengths:

- The basic elements of the concept reflect the realities of the operating environment.
- The DEPS team responds to changes within their capability and workload, removing the need for contracting these changes.

Table 5-1. Requirements Tracing to Concept

Support Requirement	DEPS Concept Elements	
	ALC/Contractor	DEPS Team
1. ECS CHANGE		
1.1 Receive and process request	From user command weapon system SPO or SM	From trainees, instructors, maintenance, user command, DEPS team
1.2 Preliminary analysis and problem/deficiency definition	ALC organic or refer to DEPS	Organic to DEPS team
1.3 Preliminary resource allocation and scheduling	ALC organic	Organic to DEPS team
2. CHANGE ANALYSIS AND SPECIFICATION	Not clearly defined, ALC resonsibility for contractual modifications	Organic or request ALC to let a contract
2.1 Feasibility	By contractor or change requestor	Organic
2.2 Requirements decomposition/definition	Not clearly defined	Organic
2.3 Preliminary design	By contractor	Organic
2.4 Detailed design	By contractor	Organic
2.5 Generate change proposal	Organic to let contract	Organic for user command approval
3. ENGINEERING DEVELOPMENT AND UNIT TEST	By contractor	Organic
3.1 Develop the change	By contractor	DEPS team
3.2 Perform engineering tests	By contractor	DEPS team
4. SYSTEM INTEGRATION AND TEST	By contractor	Organic
4.1 Test ECS system performance	By contractor	DEPS team
4.2 Test weapon system performance	By contractor at DEPS acceptance tests and kit proofing by DEPS team plus flying crews/instructors	By DEPS team plus flying crews/ instructors
5. CHANGE DOCUMENTATION	Contractor and ALC	DEPS team and ALC
5.1 Document ECS change	Contractors	DEPS team
5.2 Update ECS baseline	ALC with contractor provided documents	ALC with DEPS team, provided documents
5.3 Configuration control	ALC	ALC, although DEPS team maintains media
6. CERTIFICATION AND DISTRIBUTION	ALC	ALC and DEPS team
6.1 Certify documents	ALC distributes TCTO's	ALC
6.2 Distribute revised ECS data	ALC distributes contractor-supplied media and documents as modification kit	DEPS team authorized by ALC
6.3 Provide installation procedures/instructions	Contractor	DEPS team prepares modification kit

The DEPS concept of support to ATD causes certain support difficulties. Several of these are enumerated below.

- Configuration management is the responsibility of the ALC, but the DEPS personnel are largely assigned to the using command. The user priority tends to be on problem solving rather than configuration management.

- All software media duplication, modification merging, editing, etc., is done at the DEPS or by the contractor. Master copies of media are usually stored at the DEPS or at the contractor facilities. There is a need to clearly define the configuration management functions of the DEPS.

- Written definitions of the responsibility of ALC DEPS and user personnel were not clear and concise.

- A key element of the DEPS concept is the resident engineering representative. However, his responsibility is not clearly defined by MOA, nor does the ALC give him authority reflecting his knowledge. Most DEPS are not assigned an engineer.

Additional comments on the current ATD support concept include the following:

- Existing AFLC support concepts for ATD ECS generally do not utilize vendor maintenance nor include upgrade to the current vendor-maintained configuration of computers, peripherals and vendor's system software. Contractor maintenance supplied by the FSG-70 manager is generally utilized for this off-the-shelf computer equipment.

- Existing AFLC support concepts/procedures do not fully consider the short useful life of off-the-shelf commercial ECS. In general, spare parts (including semiconductors) are not considered by AFLC to be readily available for procurement after the systems are 8 to 10 years old. Planning for older systems is not included in support concepts.

The DEPS concept, in summary, resolves certain ECS support problems and causes others. Without the DEPS, modifications could only be performed by contractors, with the possibility of unacceptably long delays before a contract could be let. The DEPS solves this problem for the frequent ATD minor modifications, but introduces new support problems due to the dual update path, especially for systems with frequent contracted modifications. A summary of support concept evaluation is presented in Table 5-2.

Table 5-2. ATD Support Concept Evaluation

Support Requirements	Findings/Remarks
ECS Change	In concept, OO-ALC, supported by the DEPS team, can support ECS change management activities. Extreme care is required to prevent confusion on baseline due to dual update paths. Close communication between OO-ALC and the DEPS is essential. The single point for approval of change requests (OO-ALC) is not always the initial recipient.
Change Analysis and Specification	No clear definition of responsibility for this requirement was apparent. Sufficient organic engineering capability is needed to allow detailed evaluation of contractor ECP's. The approval authority is OO-ALC.
Engineering Development and Unit Test	Sufficient organic engineering capability must exist and must be permitted to attend major program reviews to allow close monitoring of contractor development/test activities. DEPS modifications are not closely monitored by the ALC.
System Integration and Test	The concept does not give a definition of the level of acceptance test formality required, i.e., are tests traceable to requirements, and procedures sufficiently detailed to allow repeatability.
Change Documentation	Up to 2 1/2 years required to update baseline after DEPS modification. Close attention required to prevent confusion on baseline when changes overlap. Major documentation changes are not independently reviewed to assure acceptably low error rates. Central data repository and master media control is desirable.
Certification and Distribution	Responsibility for this requirement is adequately defined. Because OO-ALC has formal approval authority but the DEPS or contractor distribute changes, close communication is essential. Three months are typically required to certify DEPS changes.
Concurrency	The DEPS response to change requests is not delayed by funding/procurement activities and can provide concurrency on small updates. The dual support concept should not delay contracted changes unless confusion on baseline exists.
Commercial ECS	Special support opportunities and problems of commercial ECS are not recognized in current support concepts.

5.2 EVALUATION OF SUPPORT POSTURE

The current ATD support posture has been inferred from the study of four representative systems. Table 5-3 summarizes the current ATD support posture. This support posture was analyzed in detail in Section 4-5. It should be noted that ALC/DEPS communication is improving, but not as much as is desirable. There is no reliable documentation baseline on some systems. The concurrency requirement frequently is not met in current ATD, because of ATD funding delays for contracted modifications and data flow delays for both contracted and DEPS modifications.

5.3 ATD SUPPORT PROBLEMS

During the study of the support baseline, there were five problems identified that reflect on the current support posture. The study is interested in problems of a general nature, rather than local or system-peculiar difficulties.

5.3.1 Concurrency

In general, there is a long lead time from the fielding of a change to the primary weapons system (e.g., the aircraft) until the modification of the trainer. The situation is contrary to AFR 57-4, which calls for concurrent or leading modification. Lags of over two, even three years were cited.

Lack of concurrency undermines the usefulness of the trainers. Pilots/crew members lose confidence in the devices, do not reduce their flying hours, and training objectives are not met. Any improvement of the support posture should be aimed at reducing the time lag to modification of the trainer.

5.3.1.1 Sequence

Often, the trainer modification is not defined until the aircraft modification is prototyped. This may be due to requiring actual flight test data for a trainer model, or a means of avoiding a re-engineering of the trainer modifications if the aircraft modification changes.

Table 5-3. ATD Support Posture Evaluation

Support Requirements	Findings/Remarks
ECS Change	Proposed changes evaluated by ALC or DEPS, with ALC having approval authority. ALC and DEPS communications have encountered difficulties, but are improving.
Change Analysis and Specification	DEPS performs for minor modifications, and may support the ALC in evaluating contractor prepared specifications.
Engineering Development and Unit Test	Program reviews held on contracted modifications. Program reviews usually not held on DEPS modifications. Unit tests are conducted informally.
System Integration and Test	Responsibility of modification developer. Test requirements usually not clearly defined in Acceptance Test Procedures document. Final tests are subjective by using command. No formal independent test is performed.
Change Documentation	High reliance on development contractor for documentation of all, including DEPS, modifications. CPCI Part I Specifications are not maintained. Configuration control complicated by dual paths. No reliable documentation baseline on some ATD ECS.
Certification and Distribution	Slow change certification, but improving. Distribution and installation adequate.
Concurrency	Concurrency usually does not exist. The dual DEPS/contractor update path is not an obstacle to concurrency.
Commercial ECS	Commercial ECS support generally implemented in the same manner as flight ECS (under FSG-70). Problems caused by the limited life of commercial ECS are frequently not anticipated.

For large trainer modifications, it is often necessary to obtain separate funding for the trainer modifications after the aircraft modification is approved and funded. An example was cited of a simple aircraft modification being approved without trainer modification funding, only to find that the trainer modification cost many times more. Modification programs should consider impacts, not only on the primary weapon system, but also on all support equipment including ATD. If separate funding for the trainer update is requested, the process can take three extra years. (Two years are required for budgetary action to obtain the funding. An additional year can be spent getting CCB approval for the modification, obtaining approval for the CEP, and in procurement actions up to release of contract.) Following this three year delay, typically an additional 18 months pass before contractor end item delivery.

5.3.1.2 Data Flow

Engineering data flow between developers of the aircraft and trainer modifications is required to meet the concurrency requirement. If the work is being performed by two contractors, there is reluctance to design ATD modifications based on preliminary or incomplete data. In some cases cited there was adequate information flow, indicating that good planning may alleviate the problem. A Data Item Description (DID) is being coordinated between ASD and ALC for inclusion in primary weapon system modification contracts to assure adequate ATD data flow. This DID will allow ATD contractor attendance at program reviews and provide ATD contractor consultation access to weapon system contractor personnel.

5.3.1.3 Concurrency Problem Resolution

To reduce the magnitude of the concurrency problem it is necessary for trainer modification contracts to be let early in the primary weapon system modification program. This of course increases the trainer funding risk, because considerable changes in the primary weapon system modification design may occur with resultant ECP's to the trainer. Additionally, the primary weapon system modification contractor must be tasked to provide modification working data and engineering consultation

with the trainer contractor. While these actions may increase trainer modification cost, the improvement in trainer usefulness through closer concurrence may more than offset these costs.

5.3.2 Baseline Control

Control of the baseline configuration is a basic element of the change support process. The baseline is that configuration used as the starting point to create modifications. The ECS baseline consists of both documentation and code media. There are two paths to creating changes, DEPS and OO-ALC contracting; with one authority for configuration control, Ogden ALC.

The problems are that there may be independent parallel efforts underway at any time creating modifications to the same software baseline and that the contractor's baseline often does not include DEPS-developed modifications which have not completed the approval cycle. This latter situation occurs because of the time lag between user command approval and ALC approval. One set of modifications or the other then has to be reinstalled, retested, reverified, and redocumented.

On some ATD's, e.g., F-4E, the documentation baseline is considered unreliable. This was stated to be due to the frequency of changes, which implies configuration control problems. The ALC is attempting to recover these baselines on the next major contracted modification.

Loss of baseline is possible when the DEPS installs modifications to hardware or software prior to ALC approval. It is also possible on any modification when no change auditing process is performed by the configuration management authority. The orientation of acceptance testing is, "Does the modification work?". More emphasis on documentation quality, e.g., complete and correct to the standards of that system, is needed. The lack of quality documentation results in confusion, delays, and rework costs that reduce the effectiveness of ATD support.

5.3.3 Configuration Management and Repository

Configuration management is the responsibility and function of Ogden ALC. There are two problem areas which are of concern, the ability to handle program media at Ogden, and the system for a data repository.

5.3.3.1 Media Management

In general, the ALC does not have the local ability to copy, edit, merge, and read or write software media, which is a necessary part of the CM functions. Instead, the ALC relies on either the contractor or DEPS team for this capability, including copying and changing media for distribution to additional operational sites.

5.3.3.2 Repository

At this time there is no single location where ATD technical data is stored and managed. An important part of configuration management is the job of being able to retrieve and provide copies of managed documents. It appears that the lack of such a location may limit the ability to support competitive bidding. A study of repository requirements is under way at the ALC.

5.3.4 Sole Source Contracting

It is frequently necessary for the ALC to contract sole-source for ATD modifications and for baseline documentation of DEPS generated modifications. While sole-source contracting is not in itself undersirable, the ALC should not be left without viable alternatives. A major reason for lack of contracting alternatives is the lack of a quality government owned set of baseline documentation.

5.3.4.1 ATD Modifications

As previously stated, when the documentation baseline is contractor owned or considered unreliable the ALC is attempting to recover the baseline on the next major contracted modification. Independent documentation quality audits at completion of a major contracted modification are needed

to ensure that quality improves, rather than degrades. It should be an objective of the ALC to have baseline documentation on all ATD's of sufficient quality to allow competitive procurement if that appears advantageous. It should also be an objective of the ALC to develop second sources for contracted software modifications.

5.3.4.2 Modification Engineering Analysis

The ALC has an average of about three ATD systems assigned to one engineer. This makes it unlikely that the ALC engineer will have time to analyze proposed ATD changes in depth, forcing him to rely on whatever other engineering advice and support is available, from the SM engineers or the DEPS technicians, or from the ATD modification contractor. Increased engineering support to the ALC for independent modification evaluation could increase the ALC's ability to manage the modification contractor.

5.3.4.3 Documentation of DEPS Modifications

The current method of updating baseline documentation causes the baselines to frequently be one to two years out of date. Since the DEPS provides redline documentation on all changes, it is not necessary for an experienced trainer contractor to perform documentation updates if an adequate documentation baseline exists. This work could be performed by a qualified drafting and print shop.

5.3.5 DEPS/ALC Communication

The activities at the DEPS and at the Air Logistics Center are closely interdependent. As the discussion of the concept in Section 3 shows, there are distinct roles for each. The assignment of a resident ALC engineer to the DEPS is in recognition of the need for continual communication. The information obtained for this study indicates that there is still a communication problem. Two peculiar points are the level and the role of the ALC representative.

5.3.5.1 Level of Communication

Working communication tends to be formal based on the transfer of documents, i.e., QM requests, notices of contractor changes, etc. Very often the DEPS team has not been aware of contracting activities until it has expended resources in analyzing the modification. Better informal communication is needed to supplement the current, formally supplied data whether or not the DEPS has a resident ALC engineer. The DEPS resident engineer's technical capability and knowledge has been under-utilized by the ALC. Participants feel the problem has lessened in recent months, and is not as severe as two years ago.

5.3.5.2 Role of the ALC Representative

By providing an on-site representative(s), the ALC is attempting to provide timely engineering support and improved ALC/DEPS communications. However, the role of the ALC representative has not been clearly defined by MOA. This lack of definition can lead to the ALC and DEPS having different and conflicting expectations.

5.4 ALTERNATE SUPPORT CONCEPTS

Certain variations of DEPS support, and alternatives to the DEPS concept were suggested during this study. Some of these alternatives are described below.

- Greatly expanded DEPS role - increased DEPS staffing would be accomplished largely through increased numbers of ALC engineers. This approach could improve concurrency and configuration management and increase the ALC's engineering capability, but would significantly increase support cost. Large hardware modifications would still have to be contracted.

- Increased reliance on contracted modifications - in this approach the DEPS personnel might be used to test modifications and review documentation. The approach removes baseline confusion produced by the currently existant dual update paths, but does not improve concurrency or reduce other configuration management problems. The ALC would become more dependent on the contractor for engineering support, since the level of expertise at the DEPS would probably decrease. This approach could create more problems than it solves.

- Centralize software support - in this approach the hardware capability and software personnel to support software-only modifications to a number of trainer systems would be centralized at one place (probably OO-ALC.) The central site would not need full-up copies of supported trainers, but instead would be equipped for development and unit test of software modifications. Interfaces external to the ECS would be simulated. Some DEPS activity would have to be retained to system-test modifications at a trainer site. The start-up cost of this approach (facilities, equipment, personnel training) is significant.

The candidate support approaches are to continue with the present DEPS implementation or to increase the ALC's participation in the changes by increasing the number of people under AFLC direction at the DEPS sites or at a central software support site. The support alternative decision requires a detailed study of alternative and current facility/equipment/personnel/contracting costs.

APPENDIX A

ATD EMBEDDED COMPUTER INVENTORY

This inventory lists the computers used in Aircrew Training Devices by device. It was prepared in mid-1979 and does not represent changes since then or later plans for acquisitions, such as the B-52 weapon systems trainer which is in source selection.

ITEM NO.	MANUFACTURER	COMPUTER	SYSTEM/SYSTEM TYPE/NAME	NUMBER	SOURCE LANGUAGES
1	Harris	6024/6	A/F37A-T33 (A-7D) Mission Simulator	5	Assembly
2	Data General Corp	NOVA 3/12	Automated Adaptive Flight Training (A-7D)	5	Assembly
3	IMLAC	PDS-4	Automative Adaptive Flight Training (A-7D)	5	Assembly
4	Varian Data Machines	Varian 76	SMK-98/F37 (A-7D) Dusk/Night Visual System	5	Assembly
5	Systems Eng Labs	SEL 32/35	A/F37U-T1 (F-4C) Weapon System Trainer	6	Fortran-Assembly
6	Systems Eng Labs	SEL 32/75	A/F37U-T2 (RF-4C) Weapon System Trainer	7	Fortran-Assembly
7	Singer	GP-4	A/F37U-T2 (RF-4C) Weapon System Trainer	7	Alpha Numeric Instruction Machine
8	Systems Eng Labs	SEL 32/35	A/F37U-T3 (F-4D) Weapon System Trainer		Fortran-Assembly
9	Singer	GP-4B	A/F37U-T9 (F-4E) Weapon System Trainer	16	Alpha Numeric Instruction Machine Assy Language
10	Data General Corp	NOVA 3/12	Automated Adaptive Flight Training System (F-4E)	16	Fortran-Assembly

ITEM NO.	MANUFACTURER	COMPUTER	SYSTEM/SYSTEM TYPE/NAME	NUMBER	SOURCE LANGUAGES
11	Data General Corp	NOVA 3'D	Automated Adaptive Flight Training System (F-4E)	16	Fortran-Assembly
12	IMLAC	PDS-4	Automated Adaptive Flight Training System (F-4E)	16	Assembly
13	Systems Eng Labs	SEL 32/75	Development Eng Prototype Site (F/RF-4C, F-4D)	1	Fortran-Assembly
14	Varian Data Machines	Varian 76	SMK-98/F37 (F-4E) Dusk/ Night Visual System	16	Assembly
15	Singer	GP-4B	A/F37U-T20 (F-4G) Weapon System Trainer	4	Alpha Numeric Instruction Machine Assy Language
16	Systems Eng Labs	SEL 32/75	A/F37U-T20 (F-4G) Weapon System Trainer	4	Fortran-Assembly
17	Xerox	SIGMA V	A/F37U-T14, Simulator Air-to-Air Combat (SAAC)	4	Assembly
18	Singer	GP-4B	A/F37A-T31 (F-111A) Mission Simulator	2	Alpha Numeric Instruction Machine Assy Language
19	Singer	GP-4B	A/F37A-T35 (F-111D) Mission Simulator	4	Alpha Numeric Instruction Machine Assy Language

ITEM NO.	MANUFACTUPER	COMPUTER	SYSTEM/SYSTEM TYPE/NAME	NUMBER	SOURCE LANGUAGES
20	Raytheon	703	A/F37A-T35 (F-111D) Mission Simulator	2	Assembly
21	Singer	GP-4B	A/F37A-T41 (F-111E) Mission Simulator	1	Alpha Numeric Instruction Machine Assy Language
22	Singer	GP-4B	A/F37A-T48 (F-111F) Mission Simulator	4	Alpha Numeric Instruction Machine Assy Language
23	Raytheon	703	A/F37A-T48 (F-111F) Mission Simulator	2	Machine
24	Xerox	SIGMA V	A/F37A-T36 (FB-111) Mission Simulator	9	Assembly
25	Raytheon	703	A/F37A-T36 (FB-111) Mission Simulator	4	Machine
26	Xerox	SIGMA V	AN/ASQ-T6 (FB-111) Bomb Nav Msn Simulator	2	Assembly
27	Raytheon	703	AN/ASQ-T6 (FB-111) Bomb Nav Msn Simulator	1	Machine
28	Interdata	8/32	Visual System (F-111)	10	Fortran-Assembly
29	Norsk Data	NORD-10	A/F37A-163 (F-16) Operational Flt Trainers	18	Assembly

ITEM NO.	MANUFACTURER	COMPUTER	SYSTEM/SYSTEM TYPE/NAME	NUMBER	SOURCE LANGUAGES
30	Norsk Data	NORD-50	A/F37A-T63 (F-16) Operational Flt Trainer	72	Assembly
31	Digital Equip Corp	PDP 11/35	A/F37A-T63 (F-16) Night Visual System	2	Assembly
32	Honeywell	6/43	F-16 Simulated Acft Maint Eng Set (SAME)	5	Assembly
33	Interdata	8/32	A/F37A-T58 (C-130E) Instrument Flt Simulator	2	Fortran-Assembly
34	Interdata	8/32	A/F37A-T59 (C-130E) Instrument Flt Simulator	2	Fortran-Assembly
35	Varian Data Machines	Varian 76	Visual System (C-130)	1	Assembly
36	Interdata	8/32	A/F37A-T80 (F-5E) Flight Simulator	4	Fortran-Assembly
37	Systems Eng Labs	SEL 32/55	A/F37A-T55 (A-10) Operational Flt Simulator	36	Fortran-Assembly
38	Interdata	Model 3	AN/GSQ-T26 (LGM 30) Control Monitor Procedures Trainer	2	Assembly
39	Interdata	Model 3	AN/GSQ-T27 (LGM 30) Control Monitor Procedures Trainer	1	Assembly
40	Interdata	Model 3	AN/GSQ-T28 (LGM 30) Control Monitor Procedures Trainer	1	Assembly
41	Interdata	Model 3	AN/GSQ-T29 (LGM 30) Control Monitor Procedures Trainer	3	Assembly

ITEM NO.	MANUFACTURER	COMPUTER	SYSTEM/SYSTEM TYPE/NAME	NUMBER	SOURCE LANGUAGES
42	UNIVAC	MCP 1616	AN/GSQ-T14 (LGM 30) Missile Procedures Trainer	5	Assembly
43	UNIVAC		AN/GSM-T7 (LGM 30) Ground Elct Sys Trainer	1	Assembly
44	UNIVAC	MCP 1624	AN/GSQ-T22 (LGM 30) Guided Missile Training Set	1	Assembly
45	UNIVAC	MCP 1624	AN/GSQ-T23 (LGM 30) Guided Missile Training Set	1	Assembly
46	UNIVAC	MCP 1624	AN/GSQ-T30 (LGM 30) Guided Missile Training Set	1	Assembly
47	UNIVAC	MCP 1624	AN/GSQ-T31 (LGM 30) Guided Missile Training Set	1	Assembly
48	UNIVAC	MCP 1624	AN/GSQ-T32 (LGM 30) Guided Missile Training Set	1	Assembly
49	UNIVAC	MCP 1624	AN/GSQ-T33 (LGM 30) Missile Procedures/Eval Trainer	10	Assembly
50	UNIVAC	MCP 1624	AN/GSQ-T36 (LGM 30) Missile Procedures/Eval Trainer	3	Assembly
51	Honeywell	DDP-24	AN/GSW-T2 (LGM 30) Control System Trainer	1	Assembly
52	UNIVAC		AN/GSW-T3 (LGM 30) Missile Launch Control Sys Trainer	1	Assembly

ITEM NO.	MANUFACTURER	COMPUTER	SYSTEM/SYSTEM TYPE/NAME	NUMBER	SOURCE LANGUAGES
53	Interdata	732	A/F24A-T1 (LGM 30) Airborne Launch Control Trnr	2	Assembly
54	Interdata	Model 70	AN/GSQ-T34 (LGM 30) Control Monitor Procedures Trainer	2	Assembly
55	Systems Eng Labs	SEL-840 MP	A/F37A-T37 (C-5A) Mission Simulator	5	Assembly
56	Systems Eng Labs	SEL 840A	A/F37A-T37 (C-5A) Mission Simulator	5	Assembly
57	Texas Instrument	TI-980B	A/F37A-T37 (C-5A) Mission Simulator	5	Assembly
58	Systems Eng Labs	SEL 840 MC	A/F37A-T24 (C-141A) Flight Simulator	2	Assembly
59	Control Data Corp	CDC-924	A/F37A-T24 (C-141A) Flight Simulator	2	Assembly
60	Texas Instrument	TI-980B	A/F37A-T24 (C-141A) Flight Simulator	2	Assembly
61	Systems Eng Labs	SEL-840 MC/MP	A/F37A-T24A (C-141A) Flight Simulator	6	Assembly
62	Texas Instrument	TI-980	A/F37A-T24A (C-141A) Flight Simulator	6	Assembly
63	Texas Instrument	TI-980B	Visual System (C-5/C-141A) Flight Simulators	11	Assembly

ITEM NO.	MANUFACTURER	COMPUTER	SYSTEM/SYSTEM TYPE/NAME	NUMBER	SOURCE LANGUAGES
64	Redifon	R2000A	A/F37A-T72 (E-3A) Flight Simulator	2	Fortran IV
65	IMLAC	PDS-4	A/F37A-T72 (E-3A) Flight Simulator	1	Assembly
66	IBM	CC1 (4 pi)	AN/ASQ-T12 (E-3A) Mission Simulator	1	Val (IBM Basic Assembly
67	Harris	6024/3	A/F37A-T42 (CH-3E) Helicopter Trainer	1	Assembly
68	Harris	6024/3	A/F37A-T43 (HH-53) Helicopter Trainer	1	Assembly
69	Harris	6024/4	A/F37A-T49 (F-15) Mission Simulator	21	Assembly
70	Harris	6024/4	A/F37A-T50 (T-37) Undergraduate Pilot Trnr	33	Assembly
71	Harris	6024/4	A/F37A-T51 (T-38) Undergraduate Pilot Trnr	33	Assembly
72	Varian Data Machines	Varian 76	SMK-87/F37A-T (T-37/38) Visual System	12	Assembly
73	Honeywell	H716	A/F37A-T45 Undergraduate Navigator Tng Sim (UNTS)	5	Assembly
74	Digital Equip Corp	PDP 11/20CA	AN/GSQ-29 (MATTS)	1	Assembly

ITEM NO.	MANUFACTURER	COMPUTER	SYSTEM/SYSTEM TYPE/NAME	NUMBER	SOURCE LANGUAGES
75	Xerox	SIGMA 9	AN/USQ-T3, T4, T5 Air Combat Maneuvering Instrumentation (ACMI)	6	Fortran-Assembly
76	Xerox	SIGMA 530	AN/USQ-T3, T4, T5 Air Combat Maneuvering Instrumentation (ACMI)	2	Assembly
77	Adage	Adage 330	AN/USQ-T3, T4, T5 ACMI	6	Assembly
78	Interdata	8/32	AN/USQ-T3, T4, T5 ACMI	60	Fortran-Assembly
79	Harris	6024/5	A/F37A-T1 (B-52G) Flight Simulator	5	Assembly
80	Harris	6024/5	MB-41 (B-52D) Flight Sim	5	Assembly
81	Harris	6024/5	A/F37A-T25 (B-52H) Flight Simulator	2	Assembly
82	Harris	6024/5	A/F37A-T56 (B-52G) Flight Simulator	2	Assembly
83	Harris	6024/5	A/F37A-T57 (B-52H) Flight Simulator	1	Assembly
84	Systems Eng Labs	SEL 32/35	A/F37A-T79 (C-141) Cockpit Procedures Trainer	7	Assembly
85	Harris	6024/5	A/F37A-T65 (C-5A) Cockpit Procedures Trainer	3	Assembly

ITEM NO.	MANUFACTURER	COMPUTER	SYSTEM/SYSTEM TYPE/NAME	NUMBER	SOURCE LANGUAGES
86	Singer	Mark I	A/F37A-T23 (C-135B) Flight Simulator	1	Assembly
87	IBM	CCl (4 pi)	TAU-202E (E-3A) Data Display Trainer	1	VAL (IBM Basic Assembly)
88	General Automation	SPC 16/60	AN/ALQ-T4 Electronic Warfare Simulator	23	Assembly
89	Systems Eng Labs	SEL 32/55	AN/ALQ-T5 Electronic Warfare Simulator	2	Fortran-Assembly
90	Xerox	SIGMA V	AN/GPN-T3, Air Traffic Control Simulator	4	Fortran
91	Digital Equip Corp	PDP 11/05	AN/GPN-T3 Air Traffic Control Simulator	2	Assembly
92	Systems Eng Labs	SEL 32/55	AN/GSN-T3 VFR Control Tower Trainer	2	Fortran IV
93	Singer	GP-4	Chanute Digital Procedures Training	1	Alpha Numeric Instruction Machine Assy Language
94	Data General Corp	Eclipse S/230	System Trainer and Exercise Module (STEM)	17	Fortran V

ITEM NO.	MANUFACTURER	COMPUTER	SYSTEM/SYSTEM TYPE/NAME	NUMBER	SOURCE LANGUAGES
95	Data General Corp	NOVA 3/12	System Trainer and Exercise Module (STEM)	17	Assembly
96	Honeywell	Model 6/43	AN/ASN-118, E-3A Nav Computer Sys Maintenance Procedures Trainer	1	GCOS/MOD 400 Assy and Subset ANSI-Fortran 77
97	National Semiconductor	IMP-16L/300	AN/GPN-T4, Radar Proficiency Trainer	62	Assembly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